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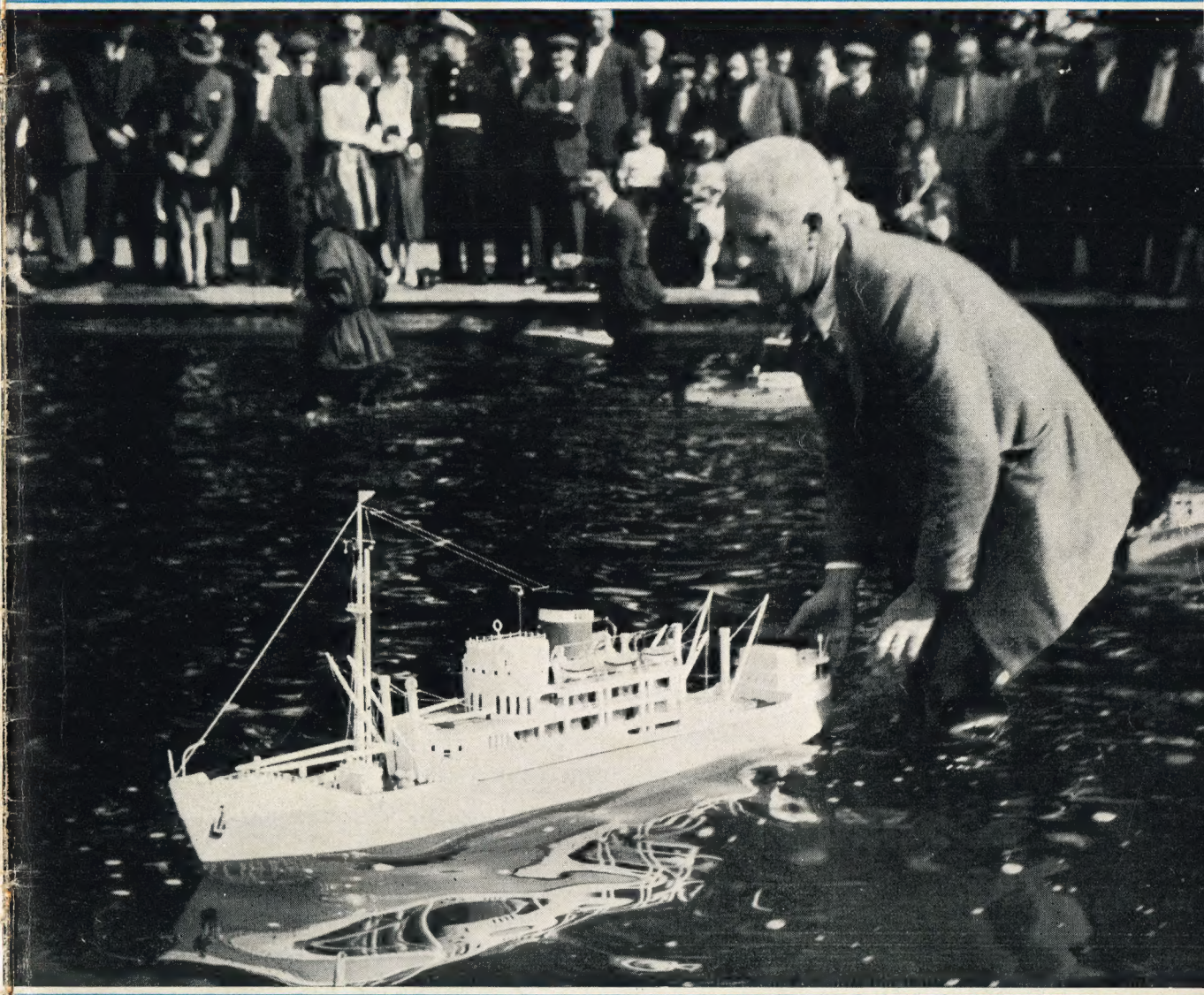

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● AN ALL-FABRICATED HEADSTOCK ● THE EVOLUTION OF THE PORTABLE ENGINE ● A HOME-BUILT POWER UNIT ● AUTOMATIC SIGNALLING ON ALL-METAL LOCO TRACKS THE STORY OF THOMAS EDISON ● QUERIES AND REPLIES

JUNE 16th 1955

Vol. 112 No. 2821

9D

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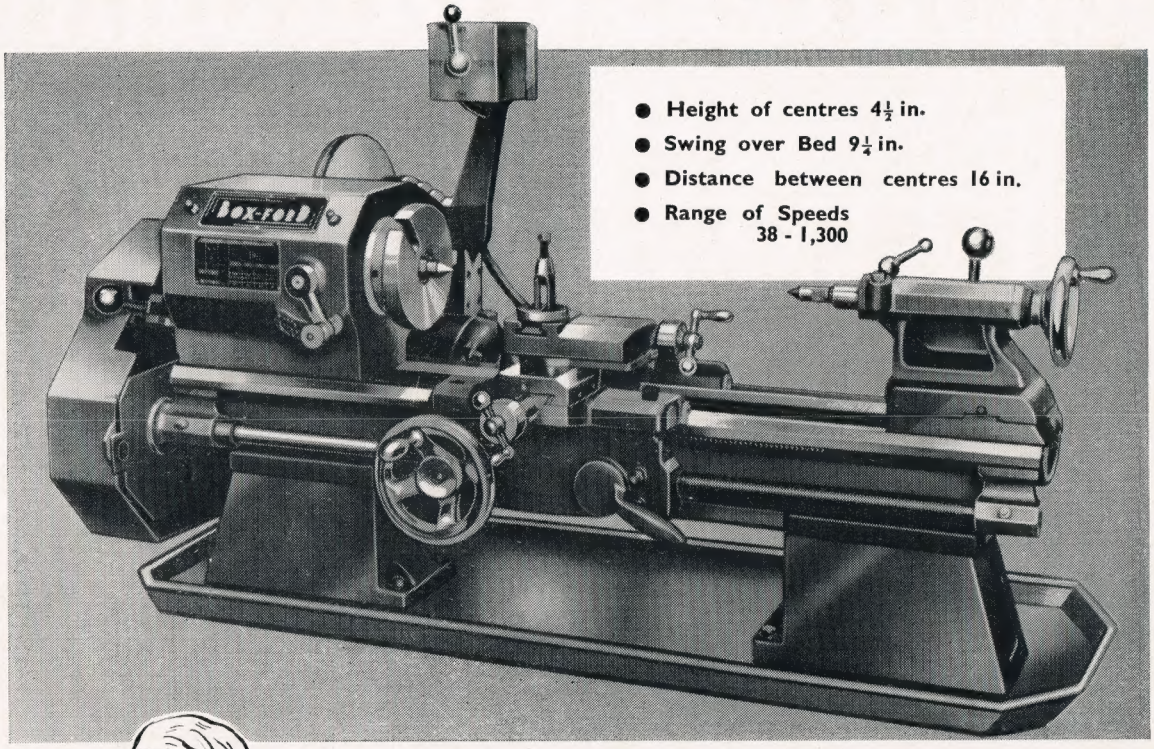

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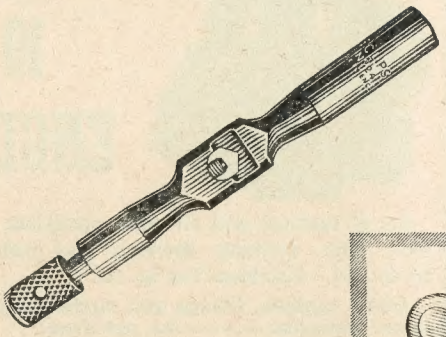

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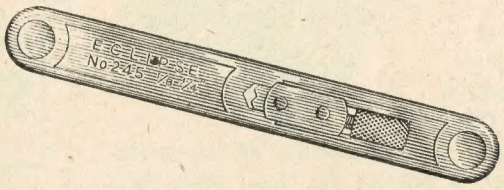

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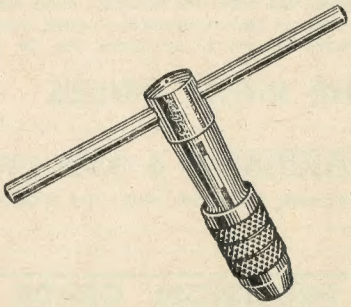

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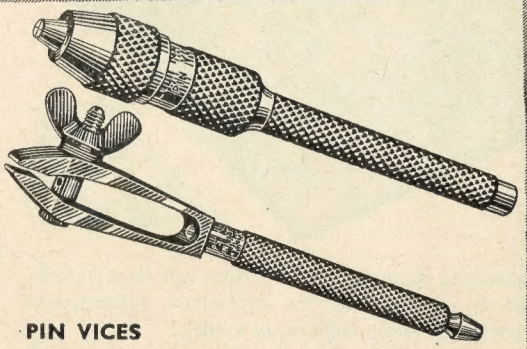

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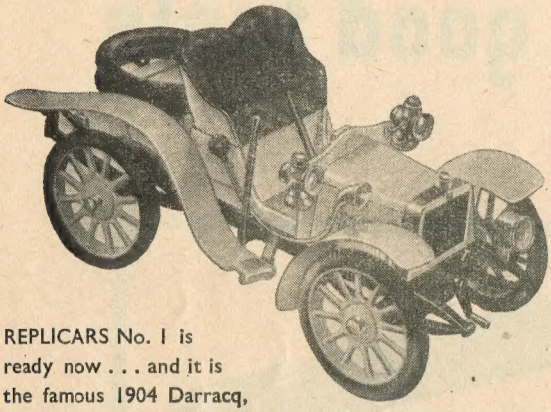

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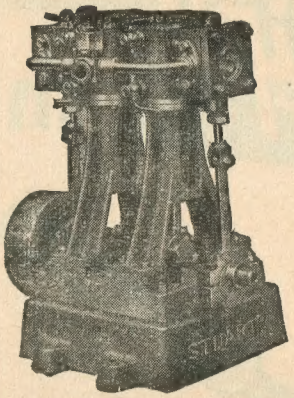

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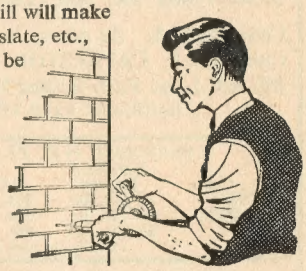

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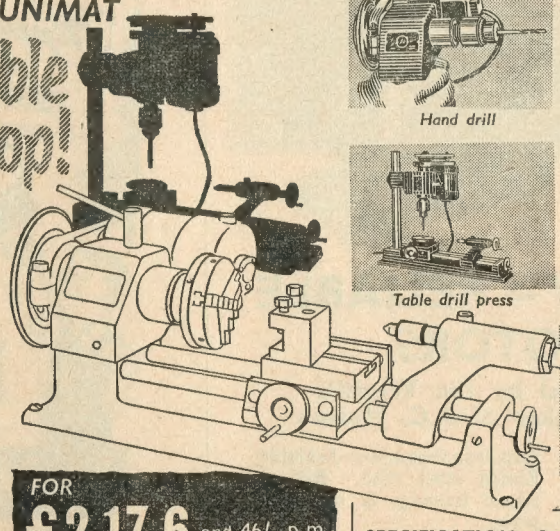

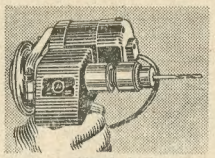

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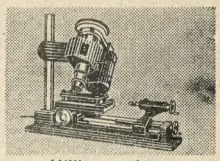

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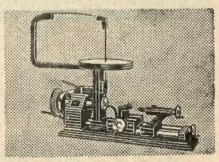

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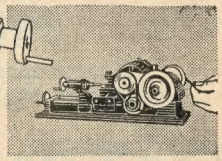

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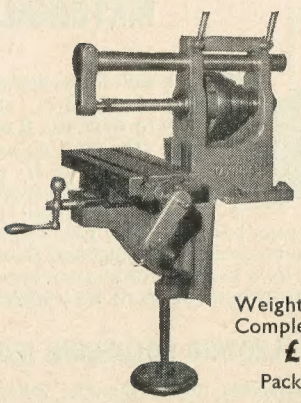

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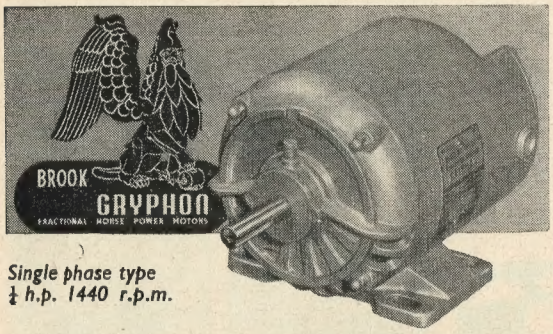

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OUR COVER PICTURE

This shows a typical example of the wide variety of models to be seen at regattas which take place nearly every weekend in various parts of the country. It is modelled on the Ellerman liner *City of Port Elizabeth*, from photographs supplied by the company, by Mr. W. Hayward, of the Southend Model Power Boat Club. The hull, which is 4 ft. 8 in. long by 9 in. beam, is layer-built in wood on the "bread-and-butter" system; propulsion is by electric motor, the current being supplied by accumulators, which also serve for navigation lights and general lighting. All details are hand made, no power tools of any kind being owned by the constructor.

SMOKE RINGS

Per Ardua . . .

OUR COMMENTS on the subject of interplanetary research in the May 5th issue have apparently been misconstrued by one or two readers, who seem to have interpreted it as a "wet blanket" attitude towards the entire subject. We hasten to assure them that we regard research work, and the pursuit of knowledge in any sphere, as worthy objects for either amateur or professional technicians. Model engineers in the past have made important contributions to progress in many branches of engineering, including machine tools, high-efficiency steam and internal combustion engines, high-speed boats, aircraft and radio-control. Although it is true that most exponents of the hobby regard it primarily as a pleasant and interesting leisure-time pursuit, it is by no means a frivolous one, and it has always been our aim to give our readers practical, if not super-scientific, information on matters in which they are interested. In this particular subject, however, we do not see how either we or they can make any serious contribution to research; our opinion still is that the resources, financial and otherwise, of model engineers are not equal to the task, but we are still open to be convinced otherwise. If, however, our critics have in mind articles on models of an imaginative kind, based on the concepts of popular science-fiction, and with conventional means of propulsion or none at all, one guess is as good as another; we do not accept this idea as "research," which should be practical and creative. "Per ardua ad astra" is a grand and soul-stirring motto, which has and will continue to inspire human beings to perform great wonders; but in many of the tasks of life, we may find a humble carthorse a more useful and certain means than the brightest distant star of hauling our wagon.

Woman at the Wheel

THE FOLLOWING story, quoted by a lady in a recent issue of the *Journal of the Birmingham Society of Model Engineers Limited*, is too good to pass by, and we make no excuse for reprinting it: "On a longish trip, I relieved my husband at the wheel of our . . . 7 h.p. car. An inexperienced driver, I was thoroughly frightened when I came round a bend to a level crossing and saw the gates smashed, the locomotive over on its side and goods trucks lying all over the place I jammed on the brake and yelled, 'What'll I do?'. My husband, who had dozed off, awoke with a start and exclaimed, as he viewed the wreckage, 'My dear, however did you do it?'."

An Australian Exhibition

THE FIFTH All Models Exhibition organised by the Australian Association of Model Societies will have the added feature of an International Trade Fair, and will be held in the Exhibition Buildings, Melbourne, from August 25th until September 10th next. The display will be made up of work by members of the Australian Model Railway Association, the Ship Modelling Society, the Surrey Hills Live Steamers, the Model Aeronautical Association and the Wireless Institute of Australia, together with commercial stands. The emphasis is, naturally, on working models, as well as on practical demonstrations in the various sections. This year, the addition of the International Trade feature, the opportunity is given for overseas modellers to send, through official model organisations, all types of models for display on stands of their countries.

Enquiries should be addressed to Miss J. H. Jeffery, 112, Maltravers Road, Ivanhoe, Victoria, Australia.

We Bow

A YOUNG reader in Hertfordshire recently wrote to ask if we would explain how hot-air engines worked. We sent him a full explanation, and we were pleased to have from him another letter to acknowledge the receipt of the particulars. He added: "I would just like to send you my thanks for taking so much trouble. Your letter has made the working of a hot-air engine clear to me, and it is very gratifying to find someone who is keen to help the younger generation."

One of our main objects is to help the younger generation in every way that we can.

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Telephone: GERrard 8811 Annual Subscription £2.2s.0d. post paid. (U.S.A. and Canada $6)

Talking about Steam—

No. 30.—THE EVOLUTION OF THE PORTABLE ENGINE

By W. J. HUGHES

IN the last article, we brought the story of the portable engine up to 1853; but before proceeding further, let us retrace our steps a couple of years, back to the peaceful scene shown in Fig. 17. The engine is a Clayton & Shuttleworth, with overhung crank, a four or five horse-power, to judge by the size of the driver in comparison. Lovely Lincoln Cathedral stands on the hill and, all in all, although hard work is in progress, the scene is one of peace and tranquility. It is reproduced from one of the last catalogues ever issued by the firm, kindly lent to me by my good friend Ned Morgan, whose Burrell *Dolly* figured in the "Coronation tea" episode.

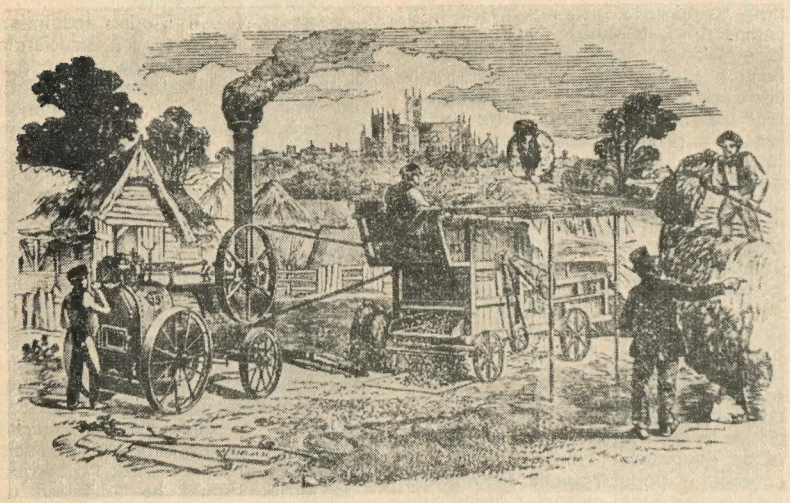


Fig. 17. A C. & S. portable of 1851, with overhung crank, pictured at work near Lincoln

Fletcher concludes his article in *Feilden's Magazine* by giving a table showing the makers who exhibited at the Great Exhibition of 1851, with the results of the trials, which are very interesting. Hornsby's engine of 6 n.h.p. took 49 minutes to raise steam using 35.23 lb. of coal in the process, and won the trials with a consumption of 6.73 lb. per horse-power hour. Tuxford's entered two engines, of six and four horse-power, and these came second and sixth on the list, respectively, with consumptions of 7.46 and 10.85 lb. per h.p. hour. Eleventh and last on the list were a firm called Roe and Company, whose four-horse engine took 83 minutes to raise steam, using 75.20 lb. of coal in the process, and finishing with a record coal consumption of 25.8 lb. per h.p. hour. As a matter of interest, it is on record that at the Lewes trials the following year, the engine of Roe and Co. eclipsed this figure completely, with the wellnigh incredible coal consumption of 93.9 lb. per horse-power hour!

Continued from page 350, *March* 31, 1955.

Removable Firebox

By now the general design of the portable engine had more or less crystallised, though naturally individual firms kept to their own ideas so far as detail was concerned. It was in detail, too, that improvements and refinements were to come, but the general principles were, to use the horizontal cylinder or cylinders, with a loco-type multi-tubular boiler. As Fletcher points out, this was truly a "survival of the fittest."

A departure from the ordinary locomotive-type boiler was to be made in 1858, when Ransomes of Ipswich introduced their patent boiler with removable firebox, as shown in Fig. 18. This was invented by two of their employees, George Arthur Biddell and William Balk. Fletcher says that early in this century the German portable engine makers were claiming this as one of their inventions, but "Ransomes used the boiler for years before it was made on the Continent."

As will be seen, the firebox and tubes, could be withdrawn from the shell, so that dirt and other incrustation could be removed and cleaned out, much more easily than from the usual type of boiler. This was a very valuable feature where the engine had to use dirty water from muddy streams and ponds—as so many had—and was particularly appreciated in engines built for export to primitive countries. Native engine-drivers frequently did not bother about regularly washing out the boiler, so long as the engine would keep running!

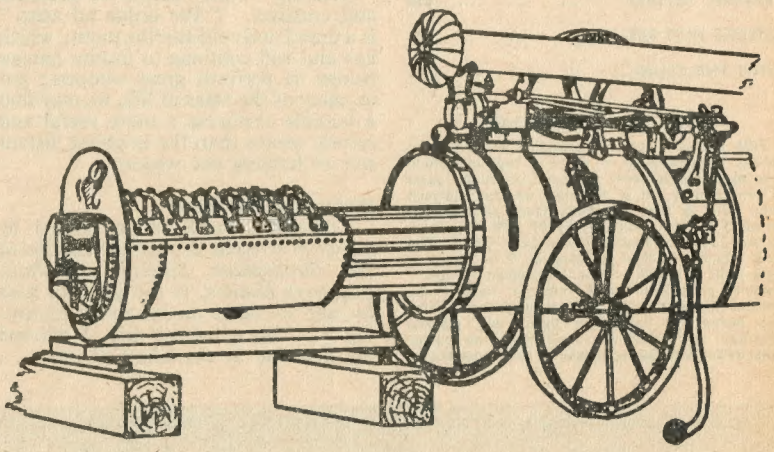


Fig. 18. Ransomes' engine of 1858, with removable firebox

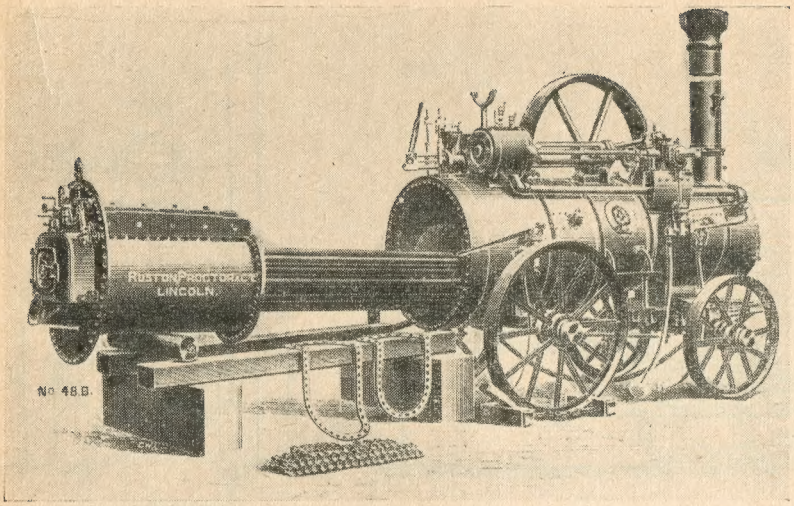


Fig. 19. Ruston, Proctor engine of 1895, removable firebox

Thus, although the vast majority of engines were built with locomotive-type fireboxes, many makers also built the removable type, and it is interesting to compare Fig. 18 with the next one, which is taken from a Ruston, Proctor catalogue of 1895, kindly lent to me by Messrs. Ruston, Hornsby of Lincoln. This shows how that removable part of the tube-plate was made smaller, to be easily withdrawn, and also shows the joint-rings and the bolts.

Other points to note on this engine, illustrated in more detail in Fig. 20, are the hand feed pump (an "extra") as well as the usual type, the Salter safety-valves, the trunk-guide, the plate-made brackets for the crank-shaft bearings, and the stays between the bearings and the cylinder. To anyone looking for an out-of-the-ordinary prototype to model, this may well be the answer! It might be argued that the firebox would be rather small, but don't forget that it is extra long, and with the long chimney and a fixed cut-off there would be a good blast.

It should be mentioned here that most makers also built engines with circular fireboxes, which were not detachable, being riveted up as usual. This was to improve the ground-clearance by several inches, for use on rough tracks.

Straw-burning

In 1873, Ransomes introduced the Head and Schemioth Patent Straw-burning Engine at the Vienna Exhibition, where, says the book "Ransomes 'Royal' Records" (published by the firm in 1939 in celebration of their centenary), "it created a great sensation." The engine was awarded a Silver Medal by the R.A.S.E. in the following year, and a "gold" at the Paris International Exhibition in 1878. Queen Victoria and the Emperor of Russia watched a working demonstration of one of the engines in 1874, the latter no doubt being particularly interested because of the invention's great value in his wheat-producing empire.

Schemioth was a Russian engineer, and John Head was a partner in the firm, who had gone out to Russia in 1853 to superintend the erection of two 40 h.p. steam engines and pumping plant for the waterworks at Warsaw. The Crimean War broke out early in 1854, of course, but Head received permission to stay on the job, subsequently receiving a valuable diamond ring from the Emperor for his services. It may well have been during this stay in Russia that the idea was first mooted, but of that I cannot be sure.

Some time ago, Mr. John R. French sent me several pages from the catalogue of that exhibition in Vienna, for which I was very grateful, of course, and among them were the illustrations of the apparatus which are now reproduced (Figs. 21 and 22). It will be seen that the straw was fed into the firebox by means of two toothed rollers, geared together. At the start the feed had to be driven by hand (Fig. 22), but after steam was raised, the hand-crank was removed, and the pulley driven by crossed belt from the small pulley on the end of the crank-shaft.

The ashpan was very deep, and the ash had to be constantly raked through the widely-spaced firebars, by means of the tines *C* and handle *f*, to avoid clogging. It was then damped down by the water-spray *h*, and raked out into the bin sunk into the ground, to be carted away as required. The firebox was enlarged because of the low calorific value of the straw.

This invention, too, proved very popular, especially in the big wheat-producing countries, but it could also be used for burning reeds, cotton, stalks, and similar waste. It was fitted subsequently to traction-engines, and to steam ploughing-engines. I have photographs of some huge ploughing-engines so fitted, which were built by Fowlers' for Russia.

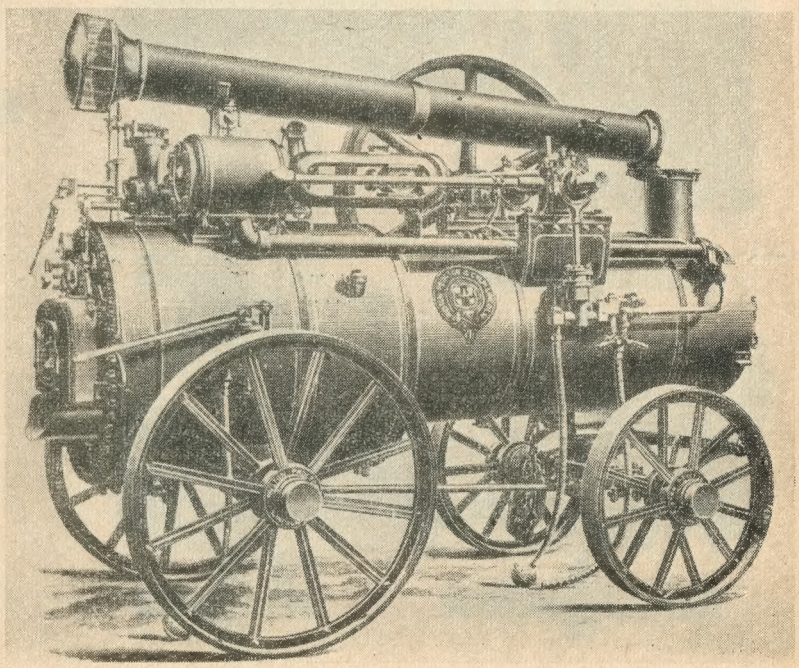


Fig. 20. A closer view of the Ruston, Proctor engine

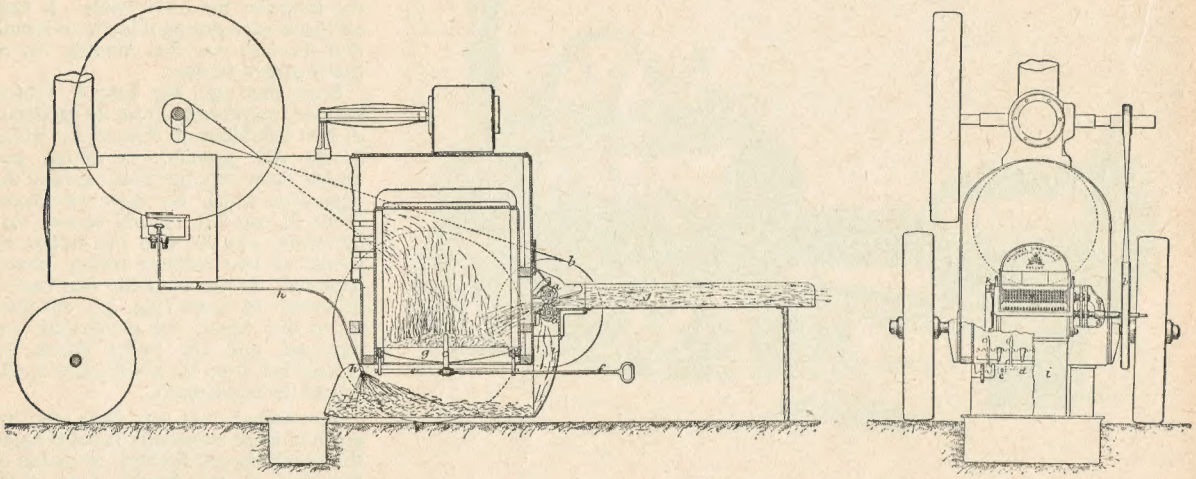


Fig. 21. Ransomes, Sims, and Head engine with straw-burning gear

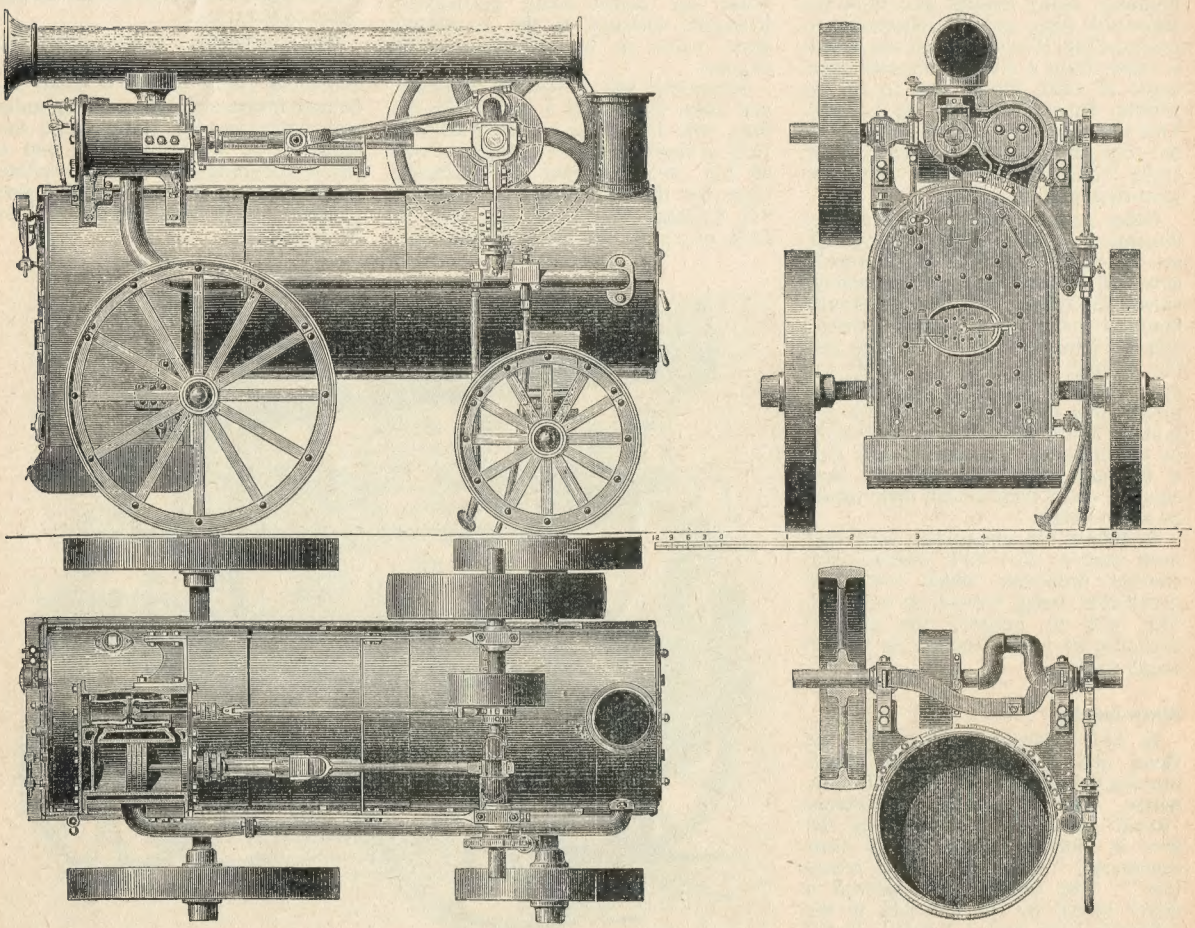


Fig. 23. Turner's engine with patent frames and crankshaft governor

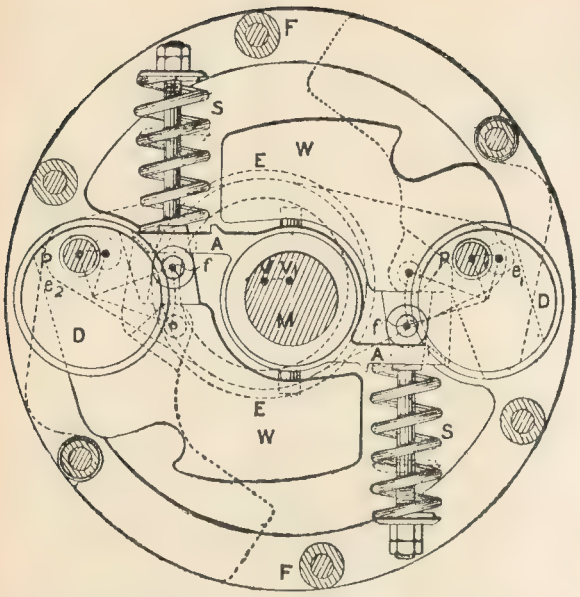


Fig. 24. The Hartnell governor, as used by E.R. and F. Turner

This engine also would make an interesting and unusual model, though whether it would actually work burning straw would be a matter for experiment. However, with that deep ash-pan nearly touching the floor, the firebox could contain a small gas-burner to assist in the heating. If the engine were mounted on a base-board, the gas supply could be brought up through the bottom of the pan, and the deception would not be noticed.

Points to note include the Salter safety-valve, the stays from cylinder to bearing-brackets, the exhaust steam bleed for heating the feed-water, and the curved-spoke flywheel. (Who was it said such spokes were not fitted to steam-engines ?) The marine-type big-end is an unusual feature for a portable, especially at that early period. Another unusual feature for a portable is that the perch-bracket is mounted under the smokebox : the more usual position was under the boiler barrel, giving a shorter wheelbase to allow easier manoeuvring in the stack-yard.

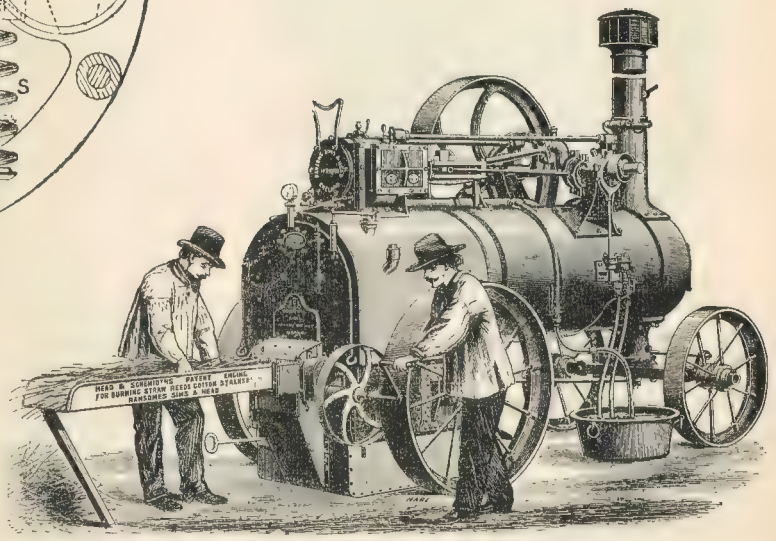


Fig. 22. Perspective view of the Ransomes straw-burning engine

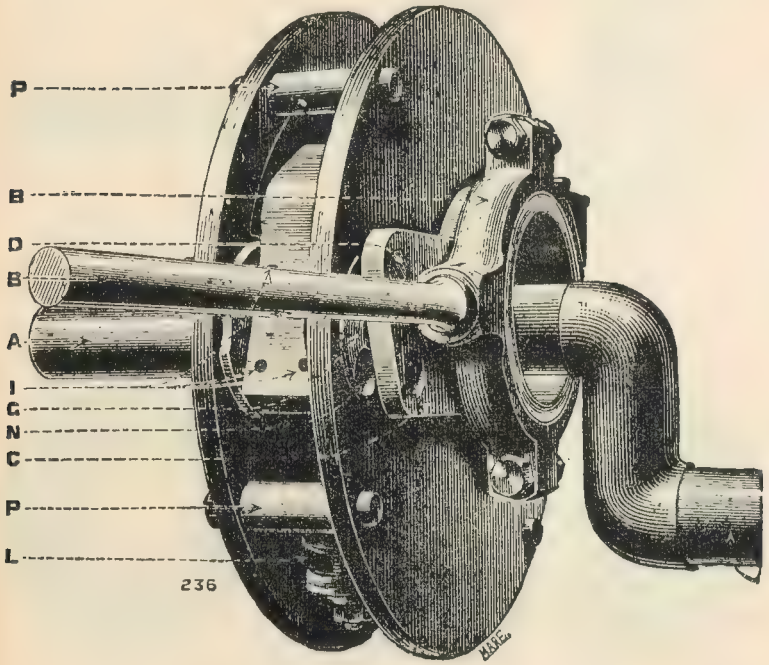


Fig. 25. Perspective view of the Hartnell governor

Expansion-gears

It is also evident from the fact that there are two eccentrics and rods, that an expansion-valve is fitted on the back of the slide-valve, but I have no information as to the type, except that quite obviously it is not automatic. However, there were quite a few engines at Vienna with automatic expansion gear, among them the one by E. R. and F. Turner of Ipswich which is shown in Fig. 25. This is an engine which is particularly suitable for modelling, especially by the fellow who likes to fabricate, because no castings would be necessary, except perhaps for the flywheel. It is fitted with Hartnell and Guthrie's patent frames; the main bearings are bolted to pieces of plate, which are riveted in turn to curved angles riveted to the boiler shell. Flat stays at each side connect the bearings to the cylinder, and to the bracket secured to it on the left. A flat stay, shaped as seen in the cross-section, supports the single slide-bar, and is bolted to the side-stays, and the pump-body is bolted to the right-hand bearing-bracket.

The cylinder is well suited for fabrication, and, unusually for the period, the

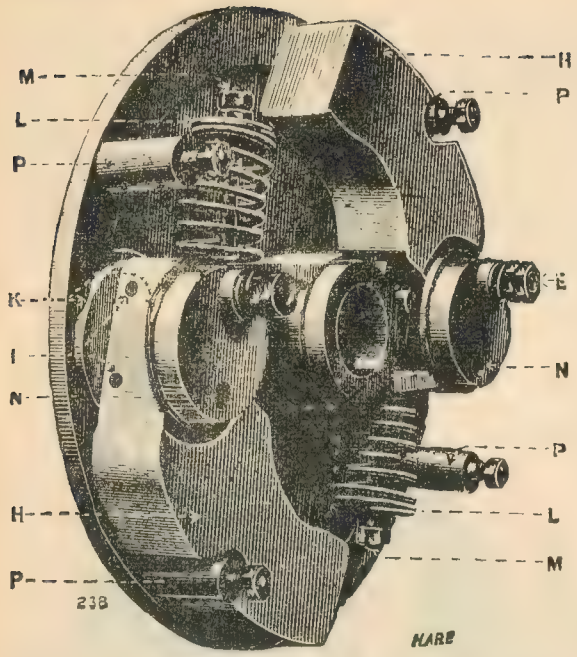


Fig. 26. Hartnell governor with eccentric and sideplate removed

valve is of the piston type, with outside admission. It will be noticed that the valve body is hollow, and that the valve-rod is attached to it by means of an eye and gudgeon-pin. The regulator-valve is of the slide-type, and is seen in the cross-section of the cylinder, above the piston-valve.

A steam-jacket surrounds the cylinder, and is surmounted by wooden lagging with a cleading-sheet. The boiler and firebox are similarly lagged, and the cleading-sheet extends over the smoke-box, too. Incidentally the door of the latter is of flat plate, hinged above the centre-line, and clamped by three dogs.

The connecting-rod is forked at the little-end, and has a marine-type big-end, which we have already noted as being uncommon for portables: Turner's subsequently used the strap-and-cotter type, as did most makers.

Crankshaft Governor

Of particular interest is the centrifugal crankshaft governor, designed by Wilson Hartnell; it was used not only by portable engine manufacturers, but also quite frequently on stationary engines, too. Different makers varied the details of design, but the principles remained the same. (There were also centrifugal shaft governors working on *different* principles, of course.)

Fig. 24 shows the modification of the governor as fitted by Turner's. Two weights, *WW*, are formed with turned bosses *DD*, which are free to turn in holes bored in the plates forming the governor body. The plates are keyed to the crankshaft, carrying the weights with them, and the centrifugal force of the weights is counter-balanced by the springs *SS*. Two pins *PP* are fitted to the bosses *D*, and the eccentric *E*, shown in broken lines, is cast on a plate which connects the two pins, and thus also connects the weights so that they work in unison. When the latter move outwards, to take up the position shown in dotted lines, the pins *PP* move from left to right of the diagram, carrying the eccentric plate and eccentric with them. Thus the centre of the eccentric moves from *V* to V_1, reducing the stroke of the valve, on which the action is very similar to varying the cut-off by Stephenson valve gear.

Figs. 25 and 26 show perspective views of the governor: in the latter the eccentric and one side disc are removed, and the weights shown in the open position. In these diagrams, the reference letters are, *A*, crankshaft; *B*, eccentric-rod; *C*, eccentric; *DD*, pins carrying the eccentric plate; *HH*, weights; and *P*, bolts with distance collars by which the discs are clamped together. The last three illustrations are copied from "Handbook on the Steam Engine," by Haeder and Powles, by courtesy of Messrs. Technical Press Ltd.

This governor was very sensitive at moderate and high speeds, and had the advantage that the engine could not "run wild" through belt slipping or gears breaking; should a spring break, the effect was automatically to slow the engine down, of course. One advantage to the model engineer, over other governors, would be that no "watch-making" would be involved, the diameter of the discs on the portable, to 1½-in. scale, would be 2¼ in.—and a further one would be the avoidance of a separate rod and gland to the governor-valve, because there isn't one! It is a well-known fact that model governors frequently are not very sensitive owing to the more-than-scale friction of the gland.

Without a doubt this would be an excellent engine to model, and we are fortunate in having scale drawings from which to work. Worked out to 1½-in. scale, the principal dimensions would be: length 14½ in., boiler barrel 9 in. long × 4 in. dia.; bore and stroke of cylinder 1⅛ in. × 1½ in.; diameter of hind wheels 6¼ in., and of front wheels 4$\frac{5}{16}$ in. An impressive model, yet not too large for the usual workshop equipment, and not too heavy to handle. It would create great interest at any exhibition, working under steam!

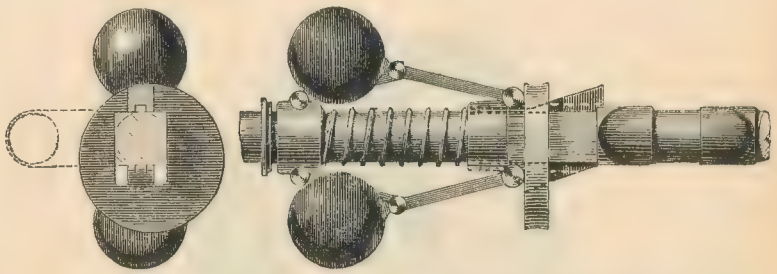


Fig. 27. Robey's automatic expansion gear, invented in 1869

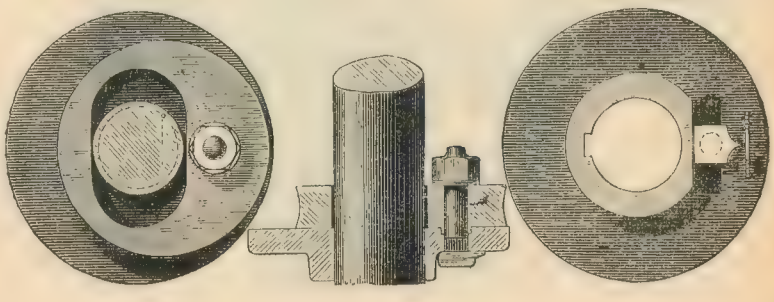


Fig. 28. Hartnell's adjustable eccentric, as used by Marshall's of Gainsborough

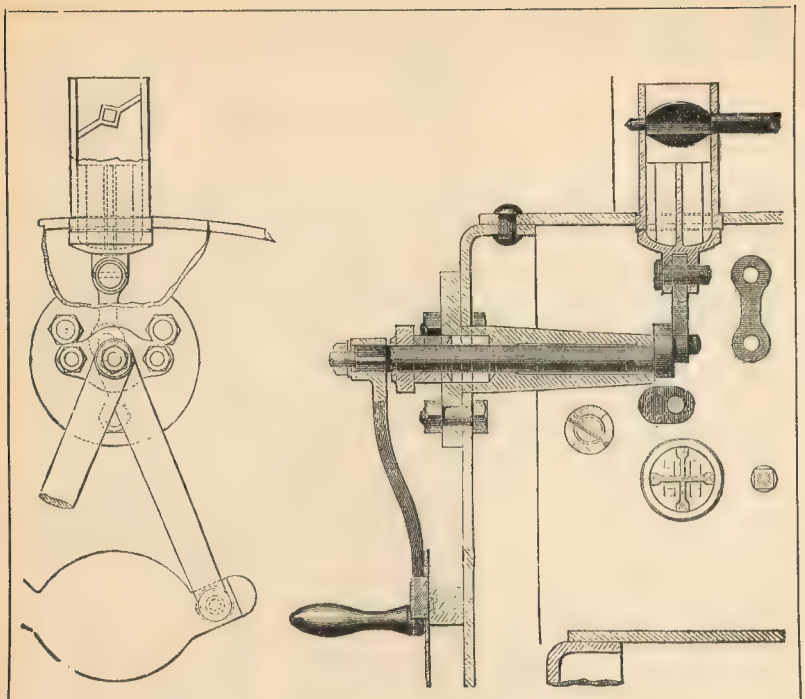


Fig. 29. Stop-valve of Ruston, Proctor portable in 1873

Other Methods

Another method of giving automatic expansion was shown at Vienna by Robeys of Lincoln, and is illustrated in Fig. 27: in this case, the shaft is squared off, and a rectangular slot is cut in the eccentric. Two wedges are attached to the movable collar of the governor, and fit similarly shaped slots in the eccentric. As the weights fly outwards, then, the wedges move the centre of the eccentric relative to that of the crankshaft, so varying the cutoff. Wansbrough mentions this as the first automatic expansion gear ever fitted to a portable: it was invented by Robert Robey and John Richardson in 1869. Another method of altering the throw of the eccentric, as shown by Marshall's of Gainsborough, is seen in Fig. 28—this was another Hartnell device which was widely used in stationary as well as in portable engines. In this case, however, adjustment was not automatic, but had to be carried out by hand when the engine was not running.

A disc keyed to the crankshaft was machined with a groove, and the eccentric, slotted out to slide over the shaft, had a matching feather machined on its back, the two being clamped together by means of a nut and bolt. A square collar under the head of the bolt prevented its rotation, and the head itself was formed into a pointer, to indicate, on the small scale attached to the disc, the position of the eccentric.

As shown, of course, the engine would be in mid-gear, but with the indicator at one end or the other of the scale, the valve would be set for either full forward or full reverse gear, with varying expansion in intermediate positions. It was one of the merits of this device that, besides being much cheaper to make than automatic expansion-gear, it did allow a quick and easy method of reversing the engine.

Other Devices at Vienna

To conclude the extracts relating to portables, from the Vienna catalogue, here are two more illustrations. The first shows the stop-valve of Ruston, Proctor's engine, in which it will be seen that the circular valve has a body of cruciform section, sliding in a cylindrical seating, which projects into the cylinder block, and also forms a housing for the governor valve. A link connects the regulator-valve to a small crank on the regulator-rod, by which it is operated. In Fig. 30, we see a device which was used by Ruston, Proctor to overcome a problem which was inherent in staying the bearing-brackets to the cylinder-block. With the expansion and contraction of the boiler, the rigidity of the stays threw great strains on the connected parts, when actually they were supposed to transfer some of the strain from the brackets to the block.

Ruston's therefore used a hollow stay, connected to the steam jacket of the cylinder, so that as the boiler warmed up and expanded, so did the stay. If you look again at Fig. 19, you will see that the firm were still using the idea 20 years later: it was evidently satisfactory ! The firm used only a single stay, by the way, to the bearing adjacent to the crank, where the thrust and pull were greatest. Actually in Wansbrough's book "The Portable Steam Engine," there is a picture of a Ruston portable dated 1911, in which the same device is still being used: Wansbrough, however, points out that (theoretically at least) it meets the difficulty only halfway, since "until steam is actually formed, no more expansion of the stay takes place than would occur in the ordinary course if the stay were solid, and heated merely by conduction." But theory or no, Ruston's must have been well satisfied in practice; the stay would be fully effective when the engine was running, when the need was greatest.

Later on, we shall see what steps other firms took to stay the crankshaft plummer-blocks, and I hope to deal with some unusual portables, including one with a turbo-generator instead of the conventional engine—a most interesting machine. We can then examine the construction of a typical portable engine in close detail, with plenty of drawings.

(To be continued)

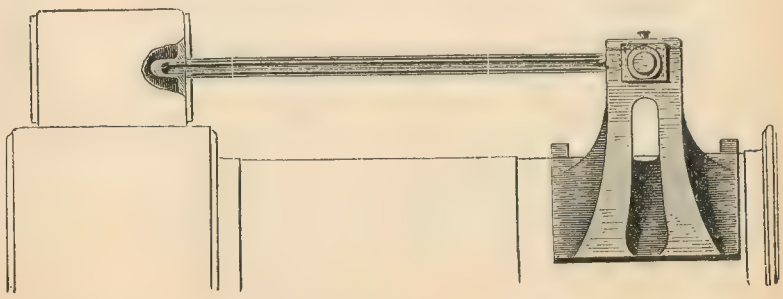


Fig. 30. Ruston, Proctor's steam-heated expanding stay

IN THE WORKSHOP
BY DUPLEX

A Home-built Power Unit

AS can be seen in the drawings, long rods pass through the cylinder-head, the cylinder, and the crankshaft bearings for the purpose of securing these parts rigidly together, with distance-collars fitted where necessary. This form of construction was adopted in the early days of motor-cycles by Messrs. Humber for mounting the engine in the frame, to replace the ordinary down-tube; later, this type of mounting was adopted by Messrs. Phelon and Moore for their very successful P. & M. machines.

The design may, however, have to be modified to accommodate a cylinder and cylinder-head of another pattern, and this is, perhaps, better so, as the short distance apart of the long tie-rods brings the crankshaft bearings somewhat close together and thereby limits the thickness of the crankshaft webs. An alternative design would be to bolt the cylinder to a crankcase top of greater thickness, and then to secure the crankshaft bearings further apart by means of long bolts, fitted with distance-sleeves, passing through the crankcase in order to make a rigid assembly.

The crankcase itself is built up from duralumin plate, secured to four vertical corner-pieces of similar material, but the joints need not be made oil-tight, for the crankcase does not form an oil reservoir, as lubrication of the bearings is by a direct feed and does not rely on splashing.

The built-up crankshaft has journals 1 in. in diameter and either end is carried in two self-aligning ball-bearings; this reduces the bending stresses on the crankpin and webs, for the latter are only ½ in. in thickness owing to the limitation of space imposed by the closeness of the long tie-bolts.

The webs were made a force-fit on the shaft and, when in place, were keyed with three silver-steel pins, driven into axially-drilled holes. The crankpin was made a force-fit in the web on the side carrying the flywheel, and a press-fit in the other web. The webs are slit so that they can be contracted on the crankpin by means of pinch-bolts and, after the crankshaft has been assembled to run truly, the two ends of the crankpin are cross-pinned. This arrangement can be regarded as a crankshaft with an overhung crankpin, and the web on the valve gear side then serves as a follower. The crankshaft, built up in this way, has never given any trouble during many years of working, and the two ends still run quite truly.

The original gear wheels were used, as they showed no material signs of wear, and could be readily mounted on the new crankshaft and half-time gear spindle. The exhaust valve cam was found to be formed integrally with its pinion, and operated a new valve tappet when fitted to the somewhat massive, hardened-steel guide. In order to obtain quieter working, the layout shown in the drawing was modified during construction, by fitting a hardened-steel pivoted follower arm between the cam and the end of the valve tappet. As the centre line of the valve spindle now became offset in relation to the tappet, the new tappet was fitted with an offset head, having a cap to receive the end of the valve stem, and a spring was added to maintain the tappet in the raised position. This arrangement enabled the valve clearance to be adjusted by means of fibre discs placed in the cup. To relieve the compression when starting the engine, a pivoted finger-lever was fitted to raise the exhaust valve, as in motor-cycle practice. The original exhaust valve was retained and only a light spring is necessary to close the valve, in view of the low speed of the engine. As can be seen in the sectional drawing, the half-time shaft is carried in three ball-bearings, and the chain sprocket for driving the magneto is secured to the outer end of the shaft.

To lessen the side thrust on the 80 mm. dia. piston, a longer connecting-rod was fitted and, at the same time, the length of the rod was adjusted to afford a low compression ratio.

The part in question was made from a car engine connecting-rod, with its length reduced by cutting off the big-end portion, and then riveting in place a housing to carry the roller-race of the new big-end bearing. The small-end bush was afterwards reduced in length to fit between the gudgeon-pin housings.

To ensure good slow running, a heavy flywheel is necessary for a single-cylinder engine; that fitted was obtained from a four-cylinder Dorman engine, and weighs some 50 lb.

This wheel had been machined with a tapered bore of large diameter, and it was secured to the new crankshaft by means of a tapered collet, which was drawn into the flywheel and, at the same

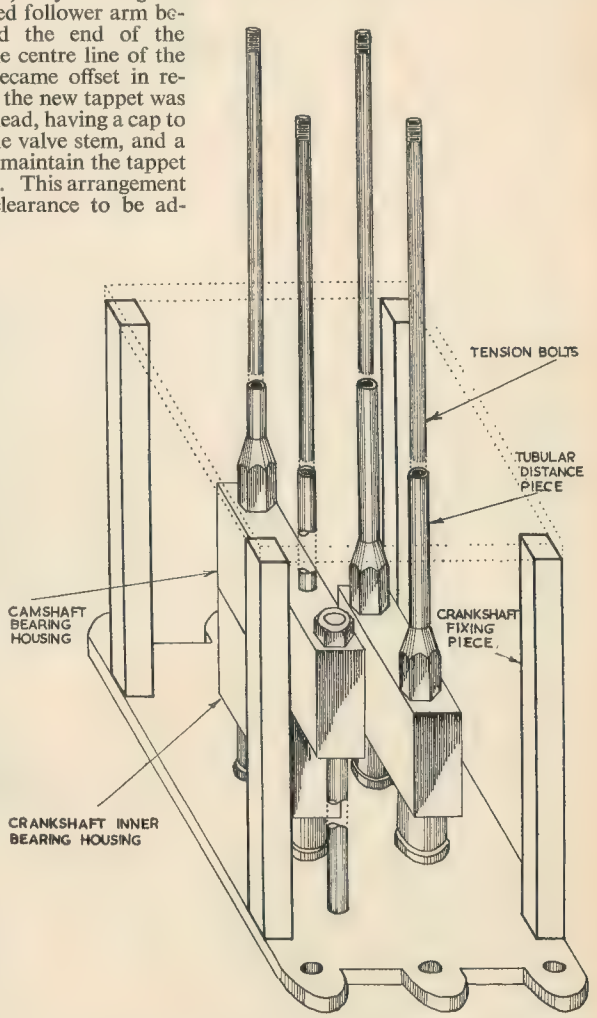


Fig. 8. Showing the arrangement of the tie-rods and the method of mounting the crankshaft and half-time gear bearings

Continued from page 618, *June* 2, 1955.

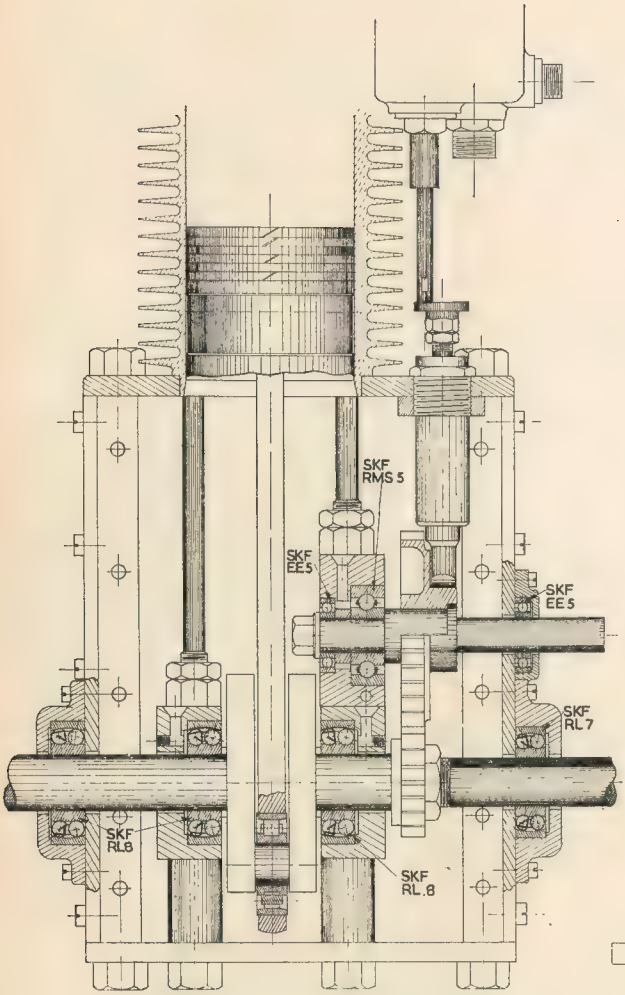


Fig. 6. Cross-sectional view of the engine

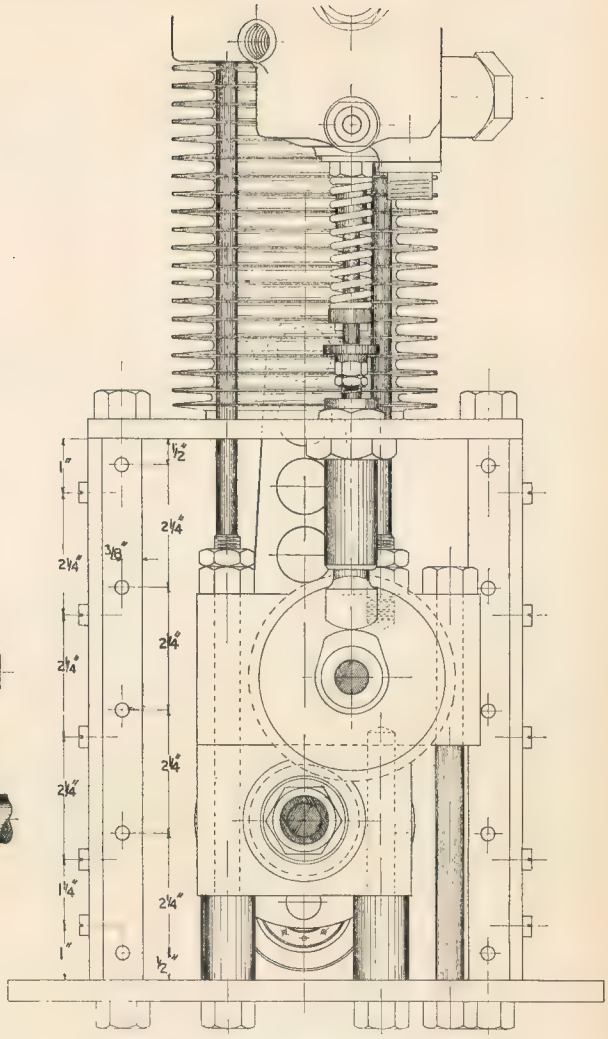


Fig. 7. Showing the layout of the valve gear

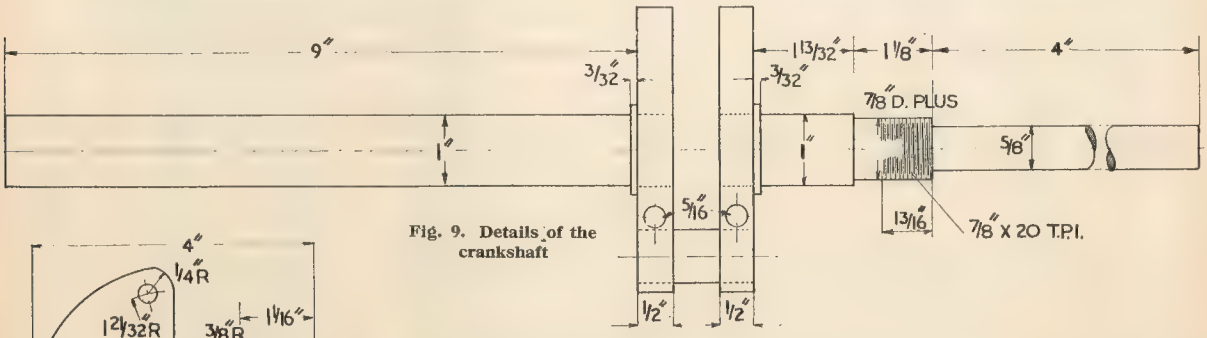
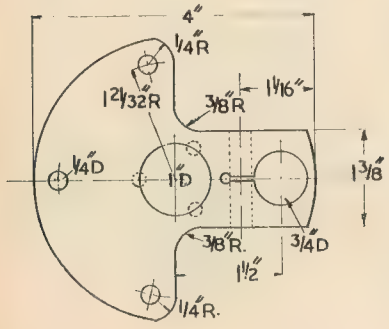


Fig. 9. Details of the crankshaft



time, contracted on the shaft by means of a ring-nut. In addition, two keys were fitted: one engaging in a keyway cut in the shaft, and the other similarly locating the flywheel. Because of the great weight of the flywheel, it should be fitted as closely as possible to the outer crankshaft bearing.

As can be seen in the previous photographs, a large cycle chain-wheel drives a smaller sprocket, mounted on a silent free-wheel which is secured to the end of the crankshaft.

The chain-wheel shaft is carried in ball-bearings, housed in brackets attached to the crankcase. The fixed starting handle was made from a cycle crank, and it enables the engine to be

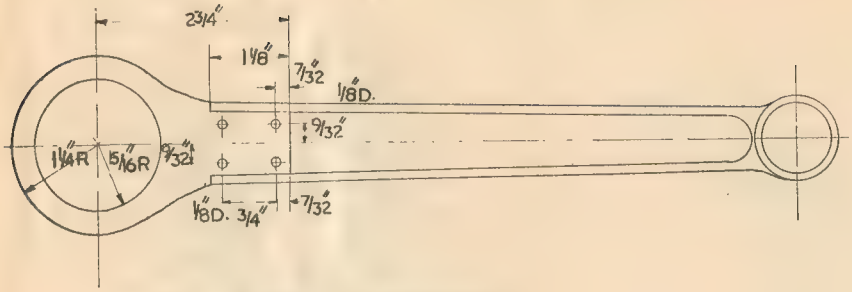


Fig. 10. The connecting-rod

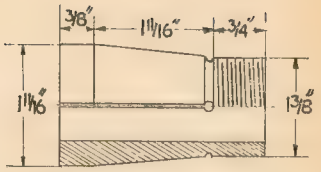


Fig. 11. The flywhee :collet

turned, through the 3 to 1 gearing, fast enough to ensure easy starting, for the magneto is driven at only half the crankshaft speed. The single-cylinder Bosch magneto is carried on a bracket attached to the crankcase, and the slotted mounting plate provides for adjustment of the driving chain.

A sight-feed lubricator, attached to the cylinder-head, supplies oil continuously to the base of the cylinder and, after lubricating the cylinder walls, the oil finds its way through the hollow gudgeon-pin to the small-end bearing. As the engine speed is low, the oil can travel down the connecting-rod and lubricate the roller-bearing fitted to the big-end.

The remaining bearings, including those of the half-time gear, are lubricated by means of oil or grease nipples, arranged along the top of the crankcase and connected to the delivery points by copper piping. Any surplus oil accumulating at the bottom of the crankcase can drain away through a vent hole, but in practice the interior of the crankcase keeps almost dry.

The use of paraffin has certain disadvantages, and petrol has always been used both for starting and running.

The fuel is fed by gravity, from a tank fixed to the wall of the workshop, through flexible piping to a J.A.P. automatic carburettor; a carburettor of this type is essential in order to cope with changes of engine speed and loading, and the induction pipe should be kept as short as possible to prevent condensation of the fuel.

The cylinder-head was originally fitted with water connections of small bore, designed for use with pump circulation; but these passages were bored out to take 1-in. dia. and $\frac{3}{4}$-in. internal dia. pipes for the outlet and inlet connections respectively. Enlarging the water passages in this way enabled thermo-siphon cooling to be adopted, and it was found that an open-ended 5-gallon oil drum held enough water to prevent any excessive rise of temperature, even with prolonged running.

The Exhaust System

To avoid being gassed, when working in a small, closed workshop, it is important to make gas-tight joints in the run of exhaust piping within the workshop. Outside, the pipe can be led into a pit, loosely filled with stones or clinker, for silencing the exhaust. In order to get rid of condensed water, the exhaust should have a downward run after leaving the engine; otherwise, water collecting in the pipe or running back into the engine will cause damage from rusting.

Governing the Engine

The maximum engine speed is limited by a hydraulic governor which is furnished with a link-rod and lever arrangement to control the opening of the automatic inlet-valve.

In the early single-cylinder and two-cylinder M.M.C. engines, this system was adopted to serve as the main throttle, and we never found that it gave any trouble. The governor unit fitted to the workshop engine consists of a small, totally-enclosed pinion pump which, according to its driven speed, builds up oil pressure to raise a piston that, in turn, operates the linkage connected to the inlet valve. As this kind of governor is suitable for controlling most types of low-speed engines, a more detailed description of the construction will, we hope, form the subject of a subsequent article.

The ordinary carburettor throttle of the engine is fitted with a finger-nut and spring, to set the running speed, and also to allow the engine to be quickly shut down to an idling speed.

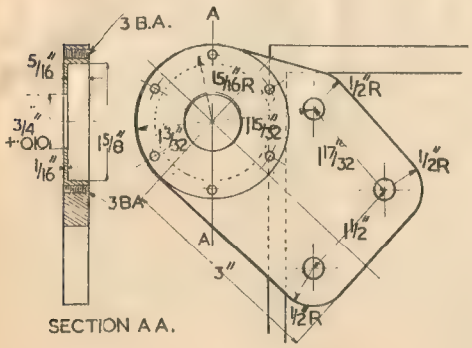


Fig. 13. The two brackets carrying the starting gear shaft in ball-bearings

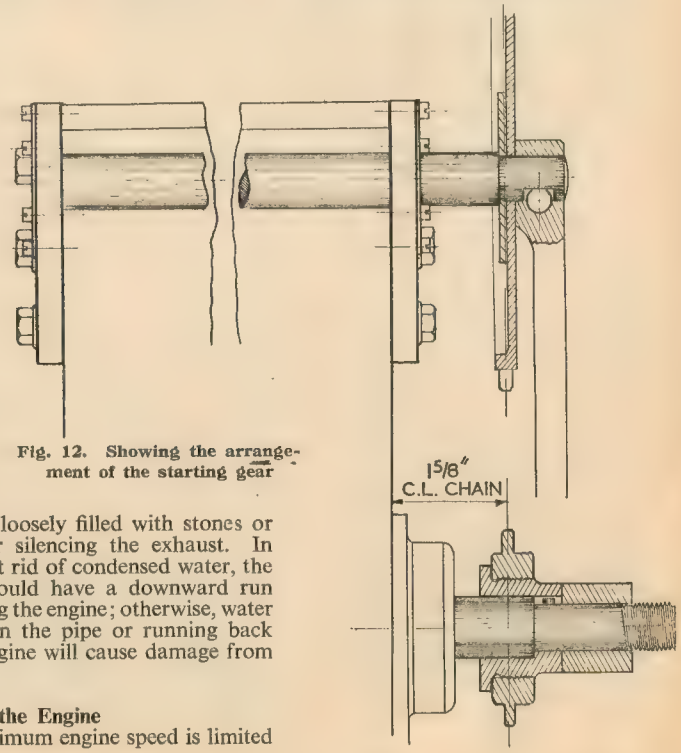
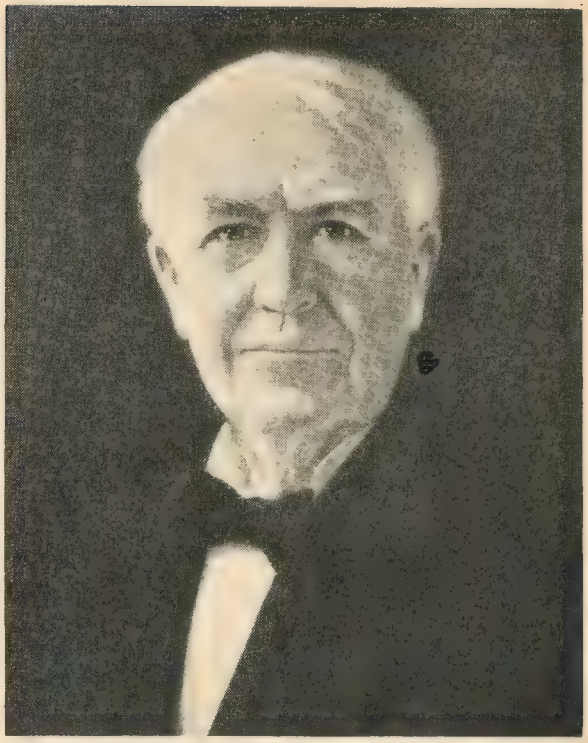


Fig. 12. Showing the arrangement of the starting gear

Thomas Edison

A LEGENDARY PIONEER

By Guy Radcliffe



HAVE you ever had an idea for an invention? Perhaps when making something in your workshop you have struck a notion that seems to have untold possibilities.

You think about it—and your enthusiasm disappears. For this, it seems, is the age of the specialist, the days when technical advances come not from the workbench but the research laboratory. If only one could have lived a hundred years ago when simple ideas (or what today seem simple ideas) were significant. How easy it is to imagine oneself a pioneer !

The name of Thomas Alva Edison, perhaps, springs to mind, and with it many of the devices of his invention which today are commonplace—the gramophone, the electric lamp—so simple to think of in principle, surely ? But such an impression is a delusion, for Edison's originating genius is obscured by the very ordinariness which now surrounds the result of his work.

It was genius nevertheless, though he defined it as ten per cent. inspiration and ninety per cent. perspiration. Let us look at this man.

When he was born in 1847, an obscure lawyer called Lincoln had just been elected to Congress. Chicago was not yet reached by the railway. The electric telegraph stretched across the country as far as Pittsburgh.

He was not a strong, healthy child. His teacher described his brain as "addled," which riled Mrs. Edison (pronounced "Eedison"), who undertook the boy's education herself. At 12 years old, Al Edison sold popcorn to passengers on the trains from Port Huron, where the family lived, to Detroit, collecting newspapers in the city for sale at the stops on the return run.

Edison noticed that whenever the papers contained news of a battle (this was during the civil war) they sold well. He arranged to visit the editorial offices to get a preview of the news columns before printing. One day they were full of General Grant's clash at Shiloh Church. Edison telegraphed the stations down the line of the tidings his papers would bring, with the result that eager crowds gathered at each stop. Towards the end of the line Edison was selling the papers at 25 cents apiece, five times more than their normal price.

Thus he had what is known as "a head for business." And at this time his interest in things scientific was beginning to assert itself. With his profits he bought text books and equipment for his laboratory at home.

One day he saved the life of a child who toddled on to the railway track in the path of a runaway carriage. The father was the station-master, who, in gratitude, taught Edison how to operate the electric telegraph. This canalised the direction of the great inventor's career.

Edison set up his own press in the train and produced a newspaper by himself. The venture ended when an angry guard ejected him and the machinery after the youth spilt a container of phosphorus on the floor. Persistent, Edison continued production at home, but eventually gave up when a libelled citizen threw the potential Press mogul into the local river.

Telegraph operating, Edison thought, would be safer. He took such a job and was required to transmit an hourly signal as a check on his vigilance. His signals were sent like clockwork, and literally. . . !

His first invention was a tape-recorder register which worked slowly enough for him and another apprentice operator to keep pace with the transcription of incoming messages. But on the night of Lincoln's re-election to the Presidency the newspapers did not receive their information quickly enough. Editors complained. The slow-motion recorder was discovered, and Edison's early association with the Western Union company soon ended after he upset a carboy of sulphuric acid which leaked through the floor to the manager's suite below. Edison was yet to make thousands of dollars out of Western Union.

His next invention was a device for totting votes in the legislative assembly. Each delegate would have one and press either the "Aye" button or the "No." A Congress committee rejected it. "Delaying the vote is the only right a minority has," they told him. Edison swore to himself then that he would never invent anything unless it was really wanted !

By the time he reached his middle twenties, he had his own laboratory in Newark. Inventions in connection with telegraphy were his main devotion. One day the Western Union company summoned him to devise a telegraph that would operate without an electro-magnet. Another inventor had secured a patent which would have enabled him to extract royalties from the telegraph companies.

Edison solved the problem that night, applying a principle learned from chance observation that moistened paper passing under the stylus of a telegraph ran quicker when the current from the stylus ran through the paper.

The many inventions for which he was responsible were not always the products of consecutive lines of research. He would work on dozens of ideas at the same time. When one came to fruition, he would turn to something else. He was working on an idea for a telephone at about the same time as Bell, but went down a side-track in search of a machine to reproduce the human voice. Then he discovered a mysterious "etheric force," and many years later his knowledge of this was usefully passed to a man called Marconi.

Bell's telephone had a pear-shaped combined earpiece and speaker, put to the ear and then to the mouth. Edison decided that separate speakers and earpieces were necessary. Also he wished to increase the volume of the

signal. He pursued various trails (one of which led to the basis of the radio loudspeaker in due course) until he found that a button of lamp-black possessed the remarkable property of changing electrical resistance in the same ratio as pressure applied to it.

Into his telephone he fixed a carbon button tight against a plate. Articulation was perfect and a whisper three feet away from the receiver could be picked up. Further, his telephone, unlike Bell's magneto type, was free from interference from induced currents. Western Union paid Edison a hundred thousand dollars for the invention.

The idea for a gramophone came to him when, by mistake, he spun the paper disc of a repeater so quickly that the needle passed in and out of the indentations and made sound. An assistant built a phonograph to his design. Edison spoke a nursery rhyme into it—and his voice was echoed. He admitted to being a little scared, as his biographer, W. A. Simonds, relates.

At the same time as he was toying with sound, he was working on problems of light. Early electric lamps were of the arc type, unsuitable for household use. Incandescence was the answer, but how to find a conductor that would remain stable while incandescent ?

Edison renewed his efforts in this direction after evolving the telephone and the phonograph. Innumerable substances were tried until, in 1879, he evolved a lamp with a cotton-thread element impregnated with carbon that stayed alight on test for forty hours. Further research brought improvements and a bamboo element was found even better. This was bent in a hairpin contour and had to be contained in a pear-shaped glass rather than a globe for the earlier horse-shoe elements.

"Give me the volume of this new glass," Edison told an assistant. The man worked for days with paper and pencil. No answer. Edison filled the glass with water and emptied it into a measure. "There's the answer," he said.

A grand scheme was drawn up to bring electric lights to New York, "the greatest adventure" in Edison's life. J. Pierpoint Morgan was in the financial background. Lighting was to be installed in houses at no cost. Payment for the service was to be made only if it were cheaper than gas. It was.

Edison devised a wiring system to save two-thirds of the cost of copper involved in the installation of main cables. Sunbury, Pennsylvania, was selected as a place to try it. One night a thunderstorm broke over the district. Residents in the local hotel, newly equipped with incandescent lights, took fright when sparks jumped from the old gas fixtures to the electric chandeliers. They rushed out to the street, but returned, relieved, when one of Edison's men told them that the building had been struck by lightning. But for the electric-light wires, he said, the building would have been destroyed.

For the lighting scheme, Edison built the largest dynamos known. The recognised law at that time was that the internal resistance of a generator should equal that of the external circuit. Incredible to us, and to Edison, who made his dynamo with a low-resistance armature. A 27-ton dynamo was shipped to the Paris Exposition of 1881, where his system gained the premier award.

At about this time another pioneer, Eastman, introduced a small camera with continuous film. The impression of movement could be given by viewing a series of pictures arranged on a revolving drum. Edison and his assistants evolved a method of mating recorded sound with motion pictures. A studio was set-up—and the film industry was born.

In 1889 he arranged for a survey of Carolina to discover low-grade magnetic ore, having made a sensitive magnetic needle which dipped and indicated its subterranean presence. Fabulous deposits were traced and an ambitious scheme was embarked upon in which the intention was no less than to tear down a mountain, pulverise it and extract the ore by magnetic means.

This enterprise lasted for five years, until Carnegie found that ore could be brought from Minnesota to Pittsburgh cheaper than Edison could supply it.

However, lessons learned were applied by Edison to the manufacture of Portland cement. He improved and lengthened the kilns in which this was processed and within a few years half the Portland cement made in the United States was in kilns of his type.

Tireless work preceded his evolution of a successful alkaline battery, later used in submarines where the absence of gas bubbles rising from the electrolyte was of obvious advantage. During the first world war he gave his services to the U.S. Government in an advisory capacity on inventions. Carbolic acid at that time could not be obtained from Europe. Edison used it for making gramophone records, the disc type by now having become common, and thus had to formulate a means of synthesising it. This was of value to other industries, and Edison did further valuable work in designing plants for the extraction of chemicals otherwise scarce.

In 1927, in his eighties, he introduced a gramophone record which played for forty minutes. His brain was active as ever and he was studying how to grow rubber in the United States. Golden Rod, he found, had a high rubber content; an acre of this hardy plant would yield 100 lb. of rubber.

If he could have another five years, he declared, he could produce a rubber crop in his native latitudes, adding that in his notebook he had ideas for another hundred years' work. In 1931 he died. How many of today's would-be inventors would just like to lay their hands on that notebook !

The photograph appearing with this article is by courtesy of Edison Swan Electric Co. Ltd.

A USEFUL DRILL SET

WE have received from the Sheffield Twist Drill Co. Ltd., Summerfield Street, Sheffield 11, a set of the new range of Dormer drills. This is classed as set No. 5, and consists of 13 high-speed straight shank twist drills of the correct tapping sizes for B.A. threads 0 to 12, housed in a cylindrical aluminium case with a flexible plastic base which holds the drills securely in place and enables the various sizes to be identified at a glance. Further information, including the actual drill sizes in metric measurement, and the clearance sizes for the corresponding B.A. threads, is printed on the outside of the case.

In view of the popularity of B.A. threads in model engineering, instrument making and electrical work, this drill set fills a long-felt want, and will be a valuable addition to the equipment of any workshop.

The drill sets can be obtained from all tool dealers.

A 10 c.c. General-purpose Four-stroke

CARBURETTOR DESIGN AND CONSTRUCTION

By

Edgar T. Westbury

THE only other item in this group of components for which a casting may be desirable is the float chamber cover, but it is almost as easy to machine this from a piece of light alloy bar, if a suitable size is available. The spigot should not be made too tight a fit in the bore of the float chamber, as it needs to be readily removable without recourse to the use of tools, and light alloy has a tendency to stick when petrol or its vapour is present. For the same reasons, the centre hole which forms a guide for the needle should be quite an easy fit for the latter; if a taper broach is available, it is a good idea to enter it from both sides to make the hole bell-mouthed. The cover can be held lightly by the spigot for machining the top surface. Finally, do not omit to drill the vent hole to prevent the possibility of an air lock in the float chamber. Knurling the rim of the cover is desirable for handling, but may be difficult if working from a casting, and is not absolutely essential.

Continued from page 618, June 2, 1955.

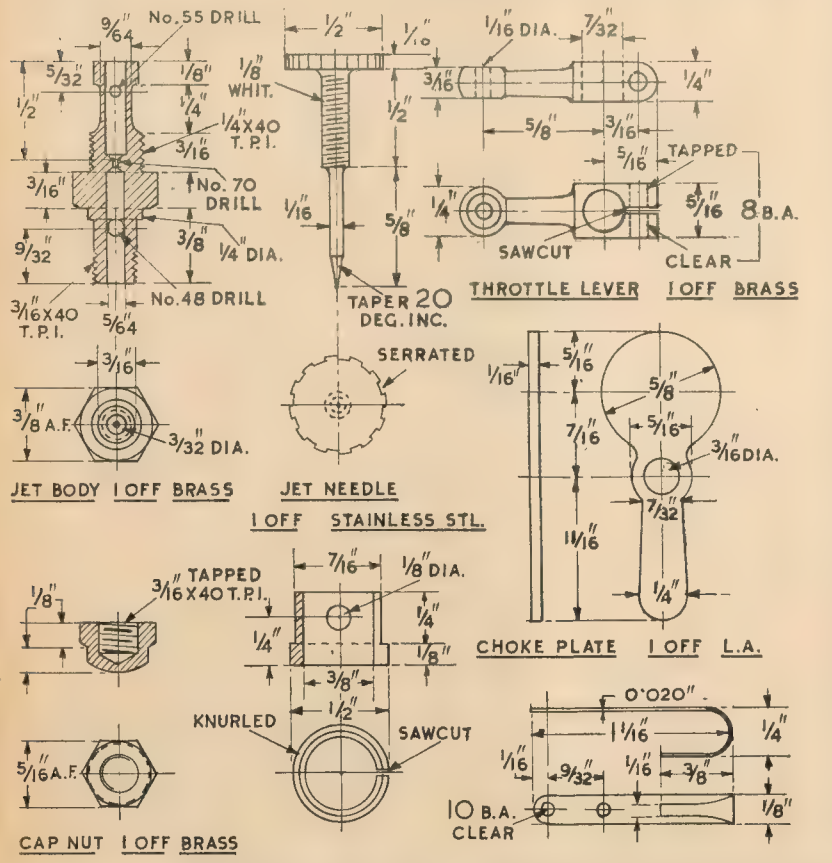
Jet Body

This item, which is made from brass, needs to be carefully machined to preserve concentricity of internal and external surfaces. I recommend that the lower part should be turned first, including the parallel portion and the screwed end; the depth of the centre hole should be accurately gauged to avoid the risk of running through the jet orifice, or on the other hand, leaving too great a length in the latter so as to introduce capillary effects, which complicate flow conditions. A piece of metal should now be held in the chuck, and drilled and tapped centrally, with a stepped counterbore to fit the jet base so that it will screw right home to the shoulder, and thus serve as a screw chuck for the remaining operations.

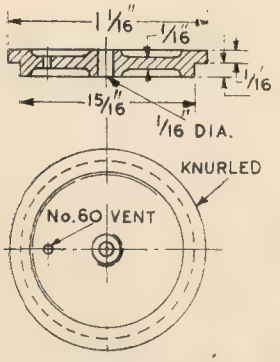
The collar at the top end of the jet well must be a close push fit in the bore of the carburettor body, as it is important that there should be no air leakage at this point. Below this, the jet is turned down to 9/64 in. dia. for a length of $\frac{1}{4}$ in., to form an annular channel, and a further $\frac{3}{16}$ in. of the length is turned to $\frac{1}{4}$ in. dia. and screwed 40 t.p.i. In jet components generally, lengths are important, as it is necessary to work accurately to designed levels, in relation to other parts; sometimes I have found that the entire object of a particular jet design is defeated by errors in this respect, or by the fitting of a fibre washer to make good a defective joint.

The centre hole should first be started with a small drill, say about No. 55, which is entered dead truly to the depth of the counterbore, namely $\frac{1}{2}$ in., and this again should be carefully gauged. I may say that I do not find it necessary to use special tailstock feed devices for drilling holes of this size; but in the case of the jet orifice, which is followed on from this bore, I always hold the drill in a pin chuck and apply it *by hand* to the rotating work. This gives a much more sensitive feed than any mechanical device which can be fitted to the tailstock, and is effective for drills up to about $\frac{1}{16}$ in., beyond which the normal screw feed, if used with care, serves all my requirements; but a higher speed than that normally employed on small lathes is very desirable. I would also emphasise that in all concentric drilling, the preliminary centre-drilling is highly important, and I use a fine-pointed centre-drill in a stub holder, fitted directly to the tailstock socket—not in a drill chuck—for these operations.

The counterbore is opened up to



3/32 in. dia. after drilling the orifice, again watching the depth. A cross hole, No. 55 or 3/64 in., is then drilled close under the collar of the jet tube, and another, No. 48 or 5/64 in., in the jet base, to line up with the passage from the float chamber. While the use of thin packing washers above and below the "banjo" which mates with the jet base is permissible, it should not be necessary if sharp tools are used,



FLOAT CHAMBER COVER 1 OFF L.A.

and due care is taken in machining. Washers of all kinds in small assemblies can be, and often are, a nuisance, especially if they are non-standard, as they are liable to fail or get lost at the most awkward moments.

For constructors who decide to dispense with float feed, the jet base may be modified as desired, omitting the cross hole, unless a banjo union is employed to connect up to the fuel tank. I have already pointed out that the main functions of the carburettor control will be operative on direct suction or gravity feed, but in the former case, at least, the advantage of the submerged jet will be lost.

The blind cap nut which secures the float chamber and closes the base of the jet calls for little comment, except to observe that the thread should be tapped deep enough to ensure that it clamps the banjo firmly, and true with the face to produce a good joint. Good, close-fitting threads are essential on all these parts, as sloppy fits will be sure to cause trouble sooner or later.

Jet Needle

The material specified for this is stainless-steel, which can be obtained in a suitable size, but it is not necessary to make it all in one piece, so long as the component pieces are true with each other and properly secured. It would be permissible to use an inserted needle, for instance, such as a chromium-plated gramophone needle; alternative materials are hard German silver or phosphor-bronze.

It should be observed that the particular taper selected for the point of the needle, in conjunction with the pitch of the thread on the shank, has been arrived at experimentally to give reasonably good compensation without "faking," but I cannot guarantee that this will work every time straight off the blue print, as small engines are notoriously unpredictable in their individual foibles, and the reports I get from constructors of my engines of earlier designs have often been confusing and contradictory. The fact remains that these things can and will give the results I claim, if a little commonsense and a lot of patience is used in adjusting them.

The serrations in the head of the needle can be planed by means of a parting tool held on its side in the toolpost, in conjunction with some means of indexing in 12 positions; it should preferably be done before parting off the head, so that rigid support is available. The alternative of coarse knurling does not provide a sufficiently positive lock of the jet adjustment, in view of the torque encountered as a result of throttle movement.

Air Sleeve

This is simply a split brass bush, bored to a push fit on the base of the carburettor body, and having a cross hole to register with a similar hole in the latter. It may be knurled on the rim, or alternatively furnished with a short lever for greater facility of operation, though it should not need to be moved when once set. To ensure a good friction fit, not liable to inadvertent movement, it may be desirable, after cutting through on one side, to squeeze it in at the sides slightly. The $\frac{1}{8}$-in. holes which form the air apertures may be drilled *in situ*, through both the sleeve and the carburettor body at once.

Choke Plate

Duralumin sheet of 16-gauge is best for this, though brass could be used. It is filed to the shape and dimensions shown, and pivots on the lower of the two spacer bushes which are interposed between the intake flange and the air baffle. Frictional loading is applied by means of a standard $\frac{3}{16}$-in. double-turn spring washer, or a short piece of heavy-gauge spring with the ends ground off flat. This component will need modification, or may be omitted, if an air cleaner or other alternative intake arrangements are fitted, but some means of restricting the intake *for cold starting only* is strongly recommended.

Throttle Lever

There are various ways of making a lever of this type, but the methods recommended are straightforward and result in a neat and satisfactory job. It is best to start from a piece of $\frac{1}{4}$-in. by $\frac{5}{16}$-in. rectangular bar, but larger material, either flat or round, may be used if it is machined or filed afterwards to the required cross-section. The bar is held in the four-jaw chuck, and set up to run axially true, then turned to form the ball end and the taper shank, shaping them as neatly as possible. To avoid the tricky job of handling such a small part for the drilling operations, they may well be carried out before parting off from the bar, thereby providing a convenient "handle" for holding it in position.

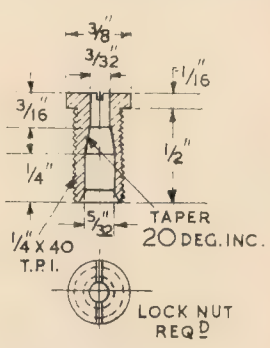
The hole to fit the throttle spindle should first be drilled No. 3 size and finished with a 7/32-in. reamer, so that it is a good push fit on the spindle. Drilling the ball end is optional, but is worth while, as it will be found necessary if and when a control rod is fitted. After drilling the cross hole, half of which is tapped and the other part opened to clearing size for 8 B.A., the lever can be sawn or parted off. It should then be split at the clamp end, either by hand saw or a circular slitting saw, and the clamp may then be used to secure it to a mandrel for skimming the top and bottom faces. Finally, the end of the clamp is rounded off, concentric with the screw hole.

Spacers

These are simply short bushes, through which the screws securing the air baffle to the intake flange pass, to leave the required air gap between these faces. If desired, three screws and spacers may be fitted, which certainly produces a stronger job, but as there is no particular reason why any great stress should ever be encountered with this fitting, two should be sufficient.

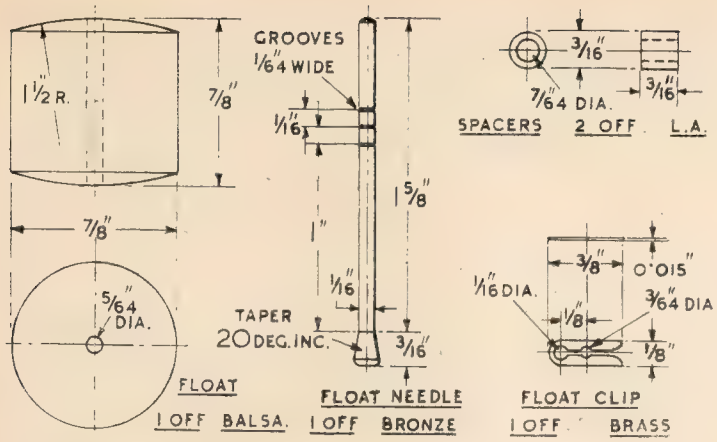
Needle Seating

Bronze is specified for this, because I find that the usual grade of brass "screw rod" does not wear very well as a valve seating, and leakage may



NEEDLE SEATING
1 OFF BRONZE

occur due to scoring and pitting after a relatively short time, despite care in original fitting. Drawn gunmetal rod is available from "M.E." advertisers, and this gives much better results. The operations on this component can be done all at one setting, with usual care to get a good external thread and a concentric hole. It is worth while to



make a small D-bit to form the seating, and a pilot both at the front and back of the taper will give adequate guidance and prevent chatter, which would obviously be fatal to producing a tight seal at the valve.

The standard form of cone union joint is specified, and it is not considered necessary to give detail drawings of the nut and nipple, but a banjo union could be used if more convenient. The 60-deg. seating for the coned nipple can, of course, be formed with a centre-drill, preferably *before* drilling and counterboring. When completed, the component is screwed in from the inside of the float chamber, and firmly secured by an external lock nut; note that the slot in the head not only enables a screwdriver to be used for screwing it in, but also prevents the possibility—not so remote as one might think—that when the float chamber is empty, entry of fuel may be sealed by the weight of the float on the flat top face of the seating.

Float Needle

It will be difficult to machine this from the solid, unless a special running-down cutter or steady tool is available, but it is quite in order to make the head and shank separately. The method I have employed with success is to use a piece of $\frac{1}{16}$-in. brass or German silver wire, which is first chucked truly, preferably in a collet chuck, and shouldered down to 0.51 in. diameter for a length of $\frac{1}{8}$ in., to take a 12 B.A. thread, or about 1 thou. larger if it is more convenient to sweat it into the head. The latter is machined from rod of suitable size in bronze, German silver, or stainless steel, with a 20-deg. included angle carefully turned on the end, and drilled No. 60 for tapping 12 B.A., or No. 55 for sweating in. For either method of assembly, the head should not be parted off yet, but retained in the chuck so that after inserting the shank, its true running can be checked, and corrected if necessary. For sweating in, smear a little "solder paint" on the tip of the shank, push it in place, and heat up with a small spirit lamp, or even a petrol lighter, to fuse the solder; any excess can be wiped off or even machined away before parting off the head. Incidentally, I have found it an advantage to make the head, not with a perfectly straight taper, but with just the suspicion of a convex curve—easily done with a small hand turning tool—and no finish with emery cloth or pivot files should be necessary, neither should the seating be "ground in"—I still hold the opinion that one cannot correct inaccuracy in acute tapers by these methods.

For grooving the shank of the needle, it should be chucked truly, as close to the position of the groove as possible; a fine parting tool is necessary, and I find that a broken hacksaw blade, clamped between two flat bars, is best for this job—to say nothing of its usefulness in other small work. It is best to locate the lower groove after putting the needle and the float in position, allowing not more than about $\frac{1}{16}$ in. minimum lift; the other two positions may never be needed, unless it is found that a higher fuel level is necessary for maximum performance.

Float

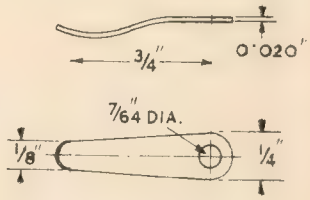
I have found that the "aeromodeller's best friend," balsa wood, makes excellent floats, being lighter than cork, and also easier to work, but in neither case is it very easy to ensure getting the hole dead central, and for this reason it will be found best to drill the hole first and "locate off bore" by threading it on a screwed rod with large washers under the nuts at each end. A hollow centre in the tailstock can then be used to support the outer end. Even so, it will have to be turned cautiously, with high speed and a sharp tool, and, when within 1/32 in. of finished size, the rest can be done with glass-paper. The ends can be faced and rounded off by chucking in a split metal bush or tube.

It is then necessary to "proof" the float very thoroughly to prevent saturation with fuel, which would destroy its buoyancy. A "filler," with a synthetic or cellulose base, used in a fairly thick state, will stop the pores, and when this is thoroughly dry, it should be rubbed down and two or three coats of suitable resistant varnish applied. So far as ordinary petrol is concerned, cellulose or spirit-based (shellac) varnish will be satisfactory, but if you use high-brow "fancy" fuels, some of which have a powerful solvent effect, I suggest that you approach some of the expert chemists who compound these fuels for advice on varnish to resist them. I may add that, for general purposes at least, such fuels are not at all necessary—all my engines are designed to use honest-to-goodness petrol "from the pump"—and the extra expense of special fuel can be justified only when it is found that in no other way can the desired results be achieved.

For those who wish to use a metal float, I may add that it is not impossible to make one sufficiently light for the purpose, and some constructors have done so in the past, but it is a rather tricky job, not the least difficult part being the soldering operation, in which only the bare minimum of solder is permissible, to avoid adding weight. It is, however, possible to use a float and needle from a standard carburettor as fitted to cycle motor engines, if complete evasion of the problem is desired.

Spring Clips

A clip made from 15-thou. brass foil to the shape shown will be found to retain the needle position securely, while being easily removable. As the thin material is difficult to handle, it will be found best to sweat it to a thicker piece, or sweat two or three clips together, when they may be drilled, slit with a small saw, and filed up on the outside before separating. Some constructors may prefer to use a wire clip, which may be made from 30-gauge phosphor-bronze wire, but it will not be found as easy as it looks to bend it exactly to the shape required.



FLOAT CHAMBER CLIP
1 OFF SPRING STL.

Both the float chamber clip and the check spring for the jet may be made from 20-thou. or 24-gauge spring steel, as sold for making laminated locomotive springs. This material is supplied in a medium temper, soft enough to

(*Continued on page* 682)

L.B.S.C.'s Lobby Chat

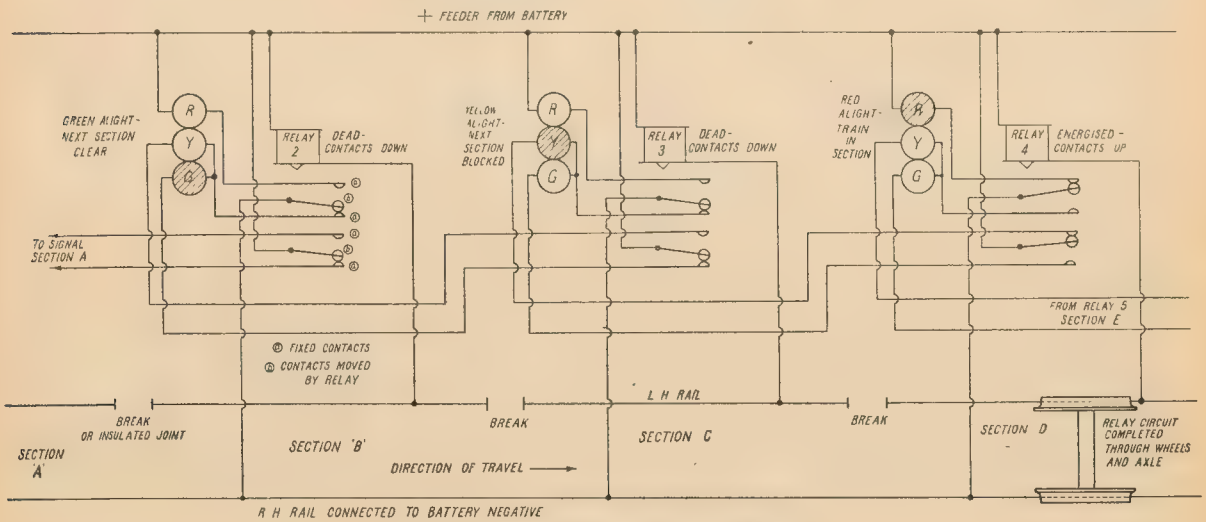
● AUTOMATIC SIGNALLING ON ALL-METAL TRACKS

IN the "wee sma' hoors" of the morning of 8th May, just as dawn was breaking—only a few hours ago, at time of writing—there was a tremendous thud from the direction of the railway bank that passes the back of our hacienda. On looking out of the back window, I noticed first that the up main home signal, which was all-present-and-correct-sergeant the previous night, had completely disappeared; then I saw that the up local home signal was minus its arm and lamp. I wondered for the moment, what the merry dickens was happening; they couldn't have blown away, as the wind was only about as strong as what the radio announcer calls "force 3 to 4." Also, there were no aircraft around, so they couldn't have been damaged by a low-flying, irresponsible pilot. Then I remembered the date; and taking another look, I saw some figures moving about on top of the bank, and somebody signalling with a torch from the direction of the station. All was well—it was only the lads of the signal and permanent-way departments, making the change from manual to automatic colour-light signalling, on the last stretch of the old L.B. & S.C.R. main line between East Croydon and Purley. There are now colour-light signals of the most modern type, all the way from London to Brighton.

The completion of the job, reminded me that I have received from time to time, queries about automatic signalling on small railways, especially those of all-metal construction. Many moons ago, I described in these notes, how I installed automatic signalling on my own road, using three different kinds of signals (variety is the spice of life !), viz., the old full-size signal from Coulsdon Station; a small edition of a modern upper-quadrant semaphore signal, on a metal post, with a "stop" arm at the top, and a "distant" underneath it; also two three-aspect colour-light signals, all of which are still working perfectly. The only trouble experienced, has been an occasional blown or burnt-out lamp, the replacement of which, is only a couple of minutes' work. The system is a simplified version of that used in full-size practice, the line being divided into three sections, each of which is track-circuited. The normal position of the signals show "line clear" (semaphores "off" and colour-lights green); the relays are actuated, and the signal aspects changed, when a train enters a section, and current runs across the wheels and axles, thus completing the relay circuit.

The Wasp in the Jam Pot

As most readers know, my line is laid with rails of a hard copper-base extruded alloy, flat-bottomed section, laid on wood sleepers; therefore the rails are automatically insulated from each other, and it was a simple matter to split up the line into sections, simply putting a tiny bit of red fibre between the ends of the rails where needed. As a matter of fact, this is only needed in summer, to prevent the rails touching, when they are fully expanded by heat of the sun. Usually there is sufficient gap between the ends, to prevent current passing from one section to another. This arrangement is not applicable to lines in which wood sleepers are not used, such as the Romford club track; and I have had several requests to describe how the system I use, could be adapted to such a line. Correspondents have told me of various ways and means that have been tried, to dispense with track-circuiting, and use switches operated by treadles, delayed-action relays, and other devices, to show a red light when the train passes the signal, plus a yellow at the preceding section, and the green aspect when the sections are clear. Mercury cups have been tried, only to be promptly emptied when a train passed over the treadle at high speed; micro-switches have failed to stand up to the battering. In my humble opinion, any kind of mechanical contact is liable to fail sooner or later, or else give false indications, and I much


+ FEEDER FROM BATTERY
GREEN ALIGHT - NEXT SECTION CLEAR
RELAY 2 DEAD - CONTACTS DOWN
YELLOW ALIGHT - NEXT SECTION BLOCKED
RELAY 3 DEAD - CONTACTS DOWN
RED ALIGHT - TRAIN IN SECTION
RELAY 4 ENERGISED - CONTACTS UP
TO SIGNAL SECTION A
FROM RELAY 5 SECTION E
FIXED CONTACTS
CONTACTS MOVED BY RELAY
L H RAIL
BREAK OR INSULATED JOINT
BREAK
BREAK
SECTION 'A'
SECTION 'B'
SECTION C
SECTION D
RELAY CIRCUIT COMPLETED THROUGH WHEELS AND AXLE
DIRECTION OF TRAVEL
R H RAIL CONNECTED TO BATTERY NEGATIVE

Circuit for simple 3-aspect automatic signals

prefer the all-electric system, which can be applied to all-metal tracks in the following simple way.

Contact Rail Solves the Problem

All that is needed to convert any all-metal line into one that can be track-circuited, is a separate insulated contact rail, which can be split up into as many sections as would be needed for a line of any given length. On a private back-garden line, where the traffic is not heavy, a plain copper wire of about 16-gauge would be quite sufficient. This could be soldered to small pieces of sheet brass, screwed down to pieces of ebonite, fibre, or hard wood, which in turn would be attached to the metal sleepers, or spacers if used. Alternatively, regular midget insulators, as used on little Milly-Amp tracks for the "juice" rail, could be used. The position of the contact wire doesn't matter a bean; it can go between the running rails, or outside them, as long as the contact shoe on the car, is fixed to the car in such a position, that it runs on the wire. The shoe is connected to the car bogie, or preferably to a brush which rubs on the axle, giving direct connection between shoe and running rails. The brush need only be a strip of brass, screwed to the bogie in any convenient place, for instance the bolster or central member. When worn, it is a matter of minutes to renew it.

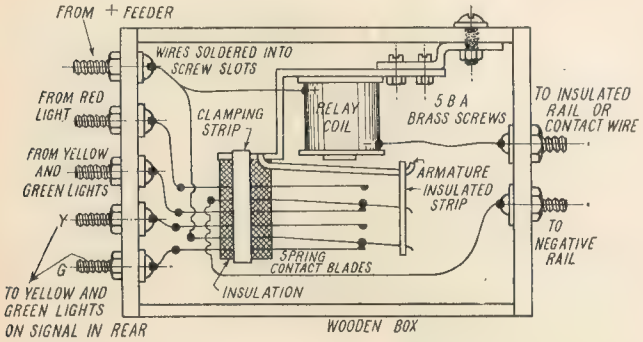
On a club track, where the traffic is usually heavy, a brass strip could be used, say about $\frac{1}{8}$-in. × $\frac{1}{4}$-in. section, attached to the metal sleepers in the same way as mentioned above. If round spacers are used, to space out the rails instead of attaching them direct to sleepers, the insulating blocks could be attached to the tops of the spacers by clips underneath, like pipe clips. In fact, there are umpteen different ways of rigging up a contact rail, quickly and cheaply, which would suggest themselves to the "signal engineer" of any interested club. All you want is a line which will carry, say, a 6-volt or 12-volt current, without any leaking away to the running rails. Mine is 12 volt; the factor which decided it, is the full-size magnetic valve which admits and releases air for the cylinder operating the full-size signal, which is wound for 12 volts.

Relays

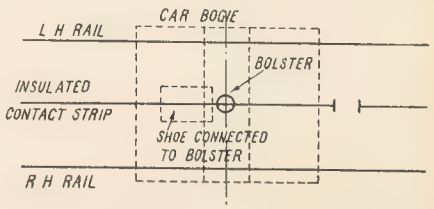
Any type of relay can be used, as long as it has a minimum of two double contacts, the movable blades making contact with one pair of fixed blades when the relay coil is "dead," or de-energised, and the other pair when "alive," or energised by the current passing through it. A relay of this type is shown in the illustration of a simple relay box as fitted to my own line. My boxes are nothing more formidable than cedarwood cigar-boxes given to me by a friend—I have never tried to smoke in my life! The relay is attached to the box by a bracket. The terminals outside the box, for connecting the wires to the contact rails and signal lamps, are 5-B.A. brass screws pushed through holes in the box and nutted outside, brass washers being put between screw-heads and nuts, to prevent them biting into the wood. The wires inside the box, connecting screws with relay contacts, are soldered into the slots in the screwheads, and to the ends of the blades projecting beyond the insulation. The wires outside the box have the ends looped over the screws, and the loops are secured by nuts and washers.

Two of my relays are of the type sold by our advertisers as R.A.F. "scrap," and can be purchased very cheaply; mine were given to me by an interested friend. They have a horizontal coil, wound for 24 volts; I adapted them for 12 volts by taking off half the coil winding. They also have eight double contacts, so if at any time I wanted to change to four-aspect signalling, I could easily do so, but life's too short; I just use two of them.

Connection to the running rails is made by drilling and tapping the web of the rail, for 3/32-in. brass screws; and the rails in each section are bonded by bits of bell-wire, secured by similar screws close to the end of each rail. Signals can easily be made by attaching three batten lamp-holders of the miniature screw type, to a piece of hardwood or fibre, and putting it inside a rectangular brass casing, with a hole cut in it, opposite each holder. Coloured glasses can be attached to the inside of the casing, over the holes. Division pieces would be needed between the lamp-holders, to keep the lamps separate; and shields or visors could be made of thin brass sheet, and soldered to the outside of the casing, over each light. Pieces of gas or water pipe make swell signal posts, as the wires can be run through the inside. At the bottom of each of my posts, just above ground level, I fitted circular junction boxes, as used for joining conduit in old-fashioned house wiring. In each of these is a thick fibre disc with terminals in it, made from 5-B.A. screws, and connected by bell-wires to the lamps at the top of the post. The wires from the relay boxes are connected to the terminals. A piece of jointing material is placed between junction box and cover, to keep out the wet.



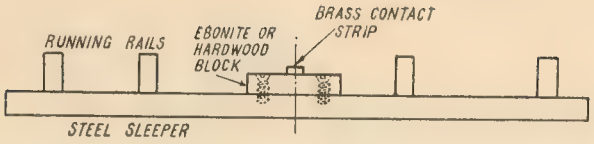
Left: Section of relay box, showing connections



Suggested contact arrangement for car bogie

Circuits Simply Explained

On a wood-sleepered track, one of the running rails is divided into as many sections as required, and the other rail is connected or bonded throughout, and connected to the negative terminal of the battery. I use a 12-volt car battery. On an all-metal track, the insulated wire or strip is sectioned, and the track itself connected to the battery neg. A signal is provided at the beginning of each section, and the relay box placed beside or under the line. My relay boxes are attached to the underside of the longitudinals by a bracket at each end. An insulated wire (bell-wire would do) is run the whole length of the line, and connected to the positive terminal of the battery. I have marked on the drawing of the relay box, exactly where to connect the wires; but to make it easy for the veriest Billy Muggins, I'll briefly repeat the connections right here. One terminal of the red light lamp-holder is directly connected to the positive wire. The top terminal of the relay box is also connected to the + wire, feeding the relay coil, and the bottom movable blade of the relay. The second terminal of the red light is connected to the second terminal of the relay box, thence to the top upper fixed contact blade. One terminal of the yellow light, and one of the green, are



Suggested method of laying contact wire or strip on all-metal track

connected together, and the common wire coupled to the third terminal on the box, thence to the top lower fixed blade. The two bottom terminals on the box, coupled to the bottom fixed blades, are connected to the terminals of the yellow and green lights on the signal in the rear; the two corresponding yellow and green light terminals on the signal we are now wiring, are connected to the bottom terminals of the relay box in the section ahead; trace them on the wiring diagram. The remaining terminal of the relay coil (top right) is connected to the sectioned running rail or contact strip; the one below it, carrying the wire from the top movable blade, is connected to the negative (—) rail direct, or the all-metal track. Each section is wired up in exactly the same manner.

Now see what happens when the trains are running. In the wiring diagram reproduced here, sections B and C are clear, but a train has just entered section D. Relay 2 in section B is dead, as the circuit is broken by the gap between the sectioned rail, or insulated strip, and the common negative running rail, or the all-metal track, as the case may be. Both movable contacts are therefore down, and as the circuit of the red light is broken at the end of the top fixed blade (see diagram) the lamp is out. The movable blade, however has dropped on to the lower fixed blade, thereby completing the circuit from the common negatives of the green and yellow lights, direct to the negative rail, which is permanently connected to the battery. The yellow and green lights, as mentioned above, are fed from the lower pair of contacts in the relay box in section C ahead; and as this is also clear, the relay is dead, and the movable blade has dropped on to the bottom fixed blade. Now, as the movable blade is directly connected to the positive (+) feed wire, "juice" is passing through it, to the bottom fixed blade, thence along the wire to the green light in section B signal; which, as we have already seen, is connected to the battery neg. via the upper movable blade in No. 2 relay, resting on the fixed blade below it, and the wire connecting the movable blade to the continuous rail or metal track. The green light is thus showing, and the driver knows that the section ahead is also clear.

Now we pass to section C. This also being clear, the relay (No. 3) is dead, the red light circuit broken, and the yellow and green lights connected to battery neg. as described above; but there is a train in the section ahead, and the movable blade in the relay box is up, making contact with its upper fixed blade. Current is therefore passing along the upper wire, back to section C signal, and lighting up the yellow lamp, warning the driver that the next section is blocked.

Finally we come to section D, in which there is a train. The wheels and axles form a bridge between the rails, on a wood-sleepered road; on the all-metal line, the bridge is formed by the shoe on the car, resting on the contact rail, and the car wheels; shoe and wheels being electrically connected, as mentioned previously. Current can therefore pass from the positive feeder, through the relay coil, to the battery neg. through this bridge, energising the relay. This immediately acts, attracting its armature and pulling up the movable blades against their upper contacts. The upper movable blade breaks the yellow and green circuits, and completes the red one, so that the red lamp lights up. The lower movable blade also makes contact with the fixed blade above it, lighting up the yellow lamp in the preceding signal, as mentioned above. The red lamp keeps alight all the time that the train is in the section; when it passes to the next section, the relay becomes dead again, and the movable blades drop, the red light going out, and the yellow coming in. When the train reaches the next section farther on, the yellow goes out, and the green comes on again.

That is all there is to it. The provision of a sectioned contact wire or insulated strip, on an all-metal railway, does away with all treadles, switches, delayed-action relays, and what-have-you. There is nothing to go wrong, and it doesn't matter a bean, how fast the trains travel; all the time that a train is in a section, the red light will show, plus the warning yellow light on the signal in the previous section. Any beginner who has no knowledge at all, of electrical work, can fix up an automatic colour-light signalling system which will work perfectly, merely by following the directions given above. Should there be anything which he fails to understand, or wants further information on some point applicable to his own railway, he has only to sing out, and I'll do my best to help, circumstances and our friend the K.B.P. permitting.

Tail Lamp Earth Wire

It always tickles me immensely when somebody or other, in a good-natured (if desperate) attempt to catch me napping, completely overlooks the obvious. I just had to smile when I read the letter from Mr. J. W. Cooper on page 489 of April 28th issue. He reckons that a length of bell-wire is insufficient for earthing a machine of the type usually found in home workshops; he doesn't say so in those words, but his last sentence implies it. Well, if one strand of bell-wire doesn't appear safe enough for our worthy friend, what on earth (subtle !) is to prevent his using *two or more strands* ?

Anyway, the Editor's footnote is quite correct; lots of people use bell-wire for earthing, as I do myself, and it is perfectly safe. Even supposing that there was a dead short between the feed line and the metalwork of the machine, all that would happen would be a blown fuse. I have heard of several cases of fires caused by defective insulation on wires carrying current from the mains, but never have heard of any trouble caused by using bell wire, or bare copper wire, for earthing.

A 10 c.c. GENERAL-PURPOSE FOUR-STROKE

(*Continued from page* 679)

"set" to shape, also to file, though it may be found difficult to drill, and punching with a flat-ended punch on a lead block is generally more satisfactory. I have, however, found that round-ended dental burrs will drill this material, and will last fairly well if lubricated with turpentine.

The jet spring, before bending, should be reduced in width at the end to fit the serrations in the head of the jet screw, but the longer leg of the bend should be kept parallel for maximum stiffness.

Two facings for the spring, on opposite sides of the carburettor body, are provided, and the spring can be fixed to either one, as found most convenient, the other being filed away if it gets in the way of the float chamber.

Incidentally, some constructors may favour other methods of retaining the float chamber cover than the clip shown, but having tried them all out at various times, I find it simple and satisfactory. The screw that holds this clip on the float chamber should not tighten hard down on it, but should either have a plain portion under the head, or be fitted tight on the thread, so that it leaves the spring just free to turn.

(*To be continued*)

An all-fabricated Lathe Headstock

By John Denver

MANY readers, especially the newcomers, have no doubt read with considerable interest the remarks, both past and present, which appear in THE MODEL ENGINEER relating to the design of the Milnes lathe headstock spindle, but unfortunately, though this information has had the useful effect of whetting the reader's appetite, nothing in the way of detailed drawings has been given.

There is no need for the writer to extol the admirable features of this lathe—it was perhaps surprising that the design was so successful as to earn it the reputation of being the best headstock spindle for the small lathe, when one considers it came about only through what was, after all, a rather drastic modification. However, this article has not been written in an attempt to add further to the many paragraphs praising the design, or to rake up ancient history, but to give some tangible guide which could apply to an existing machine, or be included on a lathe of future construction.

Now, I have already expressed my views, in a previous article, on the merits of fabrication and casting, and though I am prepared to admit cast-iron for the headstock or lathe bed is advantageous in tending to damp out vibration, this is so small with a part of these dimensions that a pattern is not worth making, and a fabricated headstock will give just as satisfactory service as the cast article.

Incidentally, many readers are literally scared stiff at cutting the outline from $\frac{3}{4}$-in. plate, but that same tool that sticks parts together—the oxy-acetylene flame—will also cut away your surplus material. So do not avoid fabrication on that score.

The Milnes headstock had an overhead arm connecting the two bearings together—an idea practised by other lathe manufacturers, notably in the U.S.A. by Messrs. Hendy Norton Ltd. This idea added much to the general rigidity, but with present-day use of vee belts and short drives, coupled, of course, with the motor behind the machine, the design is not quite so convenient—hence the probable reason why lathe makers now box the headstock casting and "tie" the bearings in the front rather than overhead. Personally, I favoured the overhead arm—it did provide a useful leaning post as the saddle traversed along the bed; but this is one point where the headstock design must differ according to particular and individual conditions.

The Design

Unfortunately, I sold my Milnes lathe during the early war years, so the sizes given on these drawings are not a slavish copy of the original article, but they are, nevertheless, close enough to allow readers to make a spindle with success. I have also altered the design slightly to suit my own ideas—some may not think any improvement has been made, but in practice I believe this headstock will give good results. I like a good flanged bush in the front bearing, and this is incorporated for that reason.

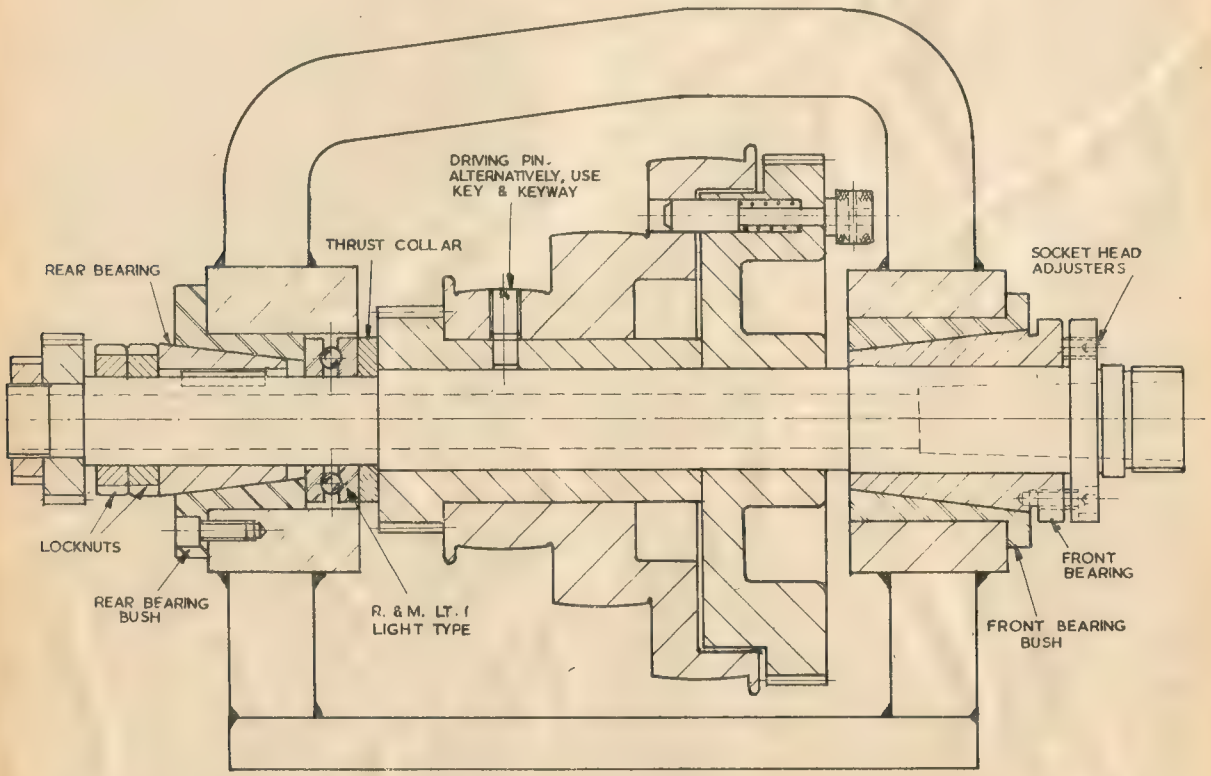


Fig. 1. An approximate cross section through the 4-in. headstock

The bearing diameters closely approximate to the original machine; I have not dismantled a Milnes lathe for the express purpose of dimensioning the drawings, and this will mean that they vary somewhat; but this is not important, because, this spindle is as robust as the modified version of the Milnes machine.

The main spindle bearing diameters are 1¼ and 1 in., and fitted to each of these are opposed taper-bearings—the front member being attached by means of cheese-headed screws, with three small grub-screws which serve as adjusters.

A flat type thrust-bearing is also incorporated at the rear end, and this bears against the inner face of the matching coned bush. The smaller taper rear bearing and two lock-nuts complete the design.

The Headstock

Fig. 2 illustrates the headstock, and for readers' guidance I have included some of the leading dimensions. The baseplate is merely a flat piece of mild-steel cut to correspond to the lathe bed facing, with perhaps a portion projecting which will enable an intending user to attach the front web which is today so popular.

Both the front and rear bearing housings are large diameter pieces of round bar, and these stand on thick steel "brackets." Welded to these latter details are two further projections which carry the backgear shaft, but if the reader has steel plate of a suitable size, then he can save time and make both the parts as one piece. This method, however, wastes material, and if this is not too plentiful, then the first method is preferred, though it may take longer to perform.

Slices cut off a black mild-steel bar are then attached to these backgear arms—the thickness depending on the width between the gears. Incidentally, I am one of those individuals who likes to see the backgear in what I will term the "old fashioned" place, behind the headstock spindle, so this is where I have drawn it.

Another point I omitted to mention in my review of this design is the cone pulley. This, as you will observe, is the old crowned type, and I admit in drawing these diameters I have not troubled to calculate the correct sizes. Thus, the diameters portrayed on this assembly have been made rather large—in fact, I doubt whether any lathe of this size has pulleys so large in diameter.

Steel plates distort just the same as castings when the skin is initially broken, and for this reason I advise all readers first to machine the face which contacts the lathe bed. Rolling stresses that are present in the metal are then released, and this usually ensures that further movement is only of a minor character.

The milling, shaping or skimming of this face on a lathe is going to prove a problem for many, but a Myford M.L.7 lathe will just about swing a plate of these dimensions. I would suggest that a cut of about 3/32 in. is necessary for this operation, whereupon it should have warped the maximum amount, say about 0.02 in.; the headstock is now ready for fabricating.

For those who intend adding the front guard joining the two bearings, this detail is perhaps more easily produced if three pieces of steel are used instead of trying to make it from a single plate. The centre portion as seen in the plan and end elevation, is cut to length and bent slightly with the aid of a bench vice; this is then attached temporarily by means of pins or screws to the base while the two side members are cut to the desired outline. As these are angular, the best way to execute the cutting-out operation is first to make a stiff cardboard template—bending and snipping it until it fits closely into the side gaps. Flatten this piece of cardboard and carefully saw out the details to a marked line. They should fit easily and without any decided gap between them and the centre piece, though the welder will fill these during the final assembly.

There are two methods that can be employed in making the connecting arm, both satisfactory, and depending on what material is available. The profile marked out on a flat sheet and the arm sawn, milled, or flame-cut is an obvious way out of the problem, but an equally shapely arm is also secured if a length of ⅜ × 1 in. section is heated under a gas flame to a bright red and bent at the two corners. This is, however, a process which is rather a tough one for the amateur workshop, and as the bench vice is probably the only bending "machine" suitable, it will take some severe punishment. In the large engineering workshops, work-pieces of this nature are bent on a slab with the aid of pins set at the required distance apart—the strip being pulled or hammered round while hot. When the shape has been secured, I suggest that the builder should now take a file and carefully radius all the corners, giving them at least a ⅛ in. radius. This adds much to the general appearance of the headstock, especially as the hands will frequently come in contact with these edges.

Machining the Headstock

Once again the question of machining the base looms large in this problem, and unfortunately, this time the assembled headstock cannot swing in the gap of the usual model maker's lathe. Secondly, accurate machining is essential if one is to avoid future troubles, so on this occasion, the absence of a machine means that some good old-fashioned hand work is required. Many are rather perturbed at hours of hand filing and scraping—usually because very little effort has been made in the past to try out the work. Some "engineer's blue" smeared on the lathe bed will reveal the high spots, and if these are removed and another trial made, quite an appreciable difference in the surface is seen. A good straight-edge is useful, but repeated trials off the lathe bed are necessary to make the face perfectly level. When the surface shows blue practically all over, particularly round the area where the drilled holes will eventually secure the headstock to the bed, then the part is sufficiently flat, and ready for the boring operation.

The boring of the bush holes is another operation guaranteed to perturb those whose daily task is generally far removed from engineering, but the work is not difficult, if care is taken to proceed slowly. You can rough-machine the bearing housings prior to welding them in position—holding each piece in a four-jaw chuck for that purpose. Leave about ⅛ in. to ¼ in. in each bore, because there is just a chance they will move slightly during that process, and will not then clean up to the desired diameters. If you drill the holes after fabricating, then first drill a ½-in. hole through one end, and use progressively larger drills until it becomes necessary to apply a boring bar. Open out the diameter to about ⅛ in. smaller than the finished size and then if you do not possess extension drills, reverse the headstock and repeat the work on the opposite end. Care in setting is essential if the holes are to pierce the housings reasonably in line, and for work of this type in the modern tool room, an edge is usually machined against which the borer pushes the work-piece each time he makes a new setting.

This, however, is not really needed in this case, if before the drilling and boring stage, the reader will mark out on each outer face of these housings a pair of cross-lines indicating where the holes must commence. Drilling the small ½-in. dia. hole relieves the pressure required to push the tool through the material, and following drills will cut easily and without any tendency to deviate from the true path too much. If you previously rough bore the bushes, this latter operation of marking the centre-lines is not necessary, as the body is not disturbed after the initial setting.

We have proceeded too quickly, because I have not described how to hold this headstock while the boring operation is taking place, and it had been my original intention to suggest suitable packing blocks beneath the headstock and tailstock, but this I am afraid is perhaps a little too complicated for most readers.

An alternative idea is to clamp the fabricated body to the lathe bed, and to assist this process, two holes drilled through the floor are needed—bolts can then pass down and clamps under the shears will hold it securely. This is probably the best arrangement, because the headstock locating surface and the bed are usually the same height, so

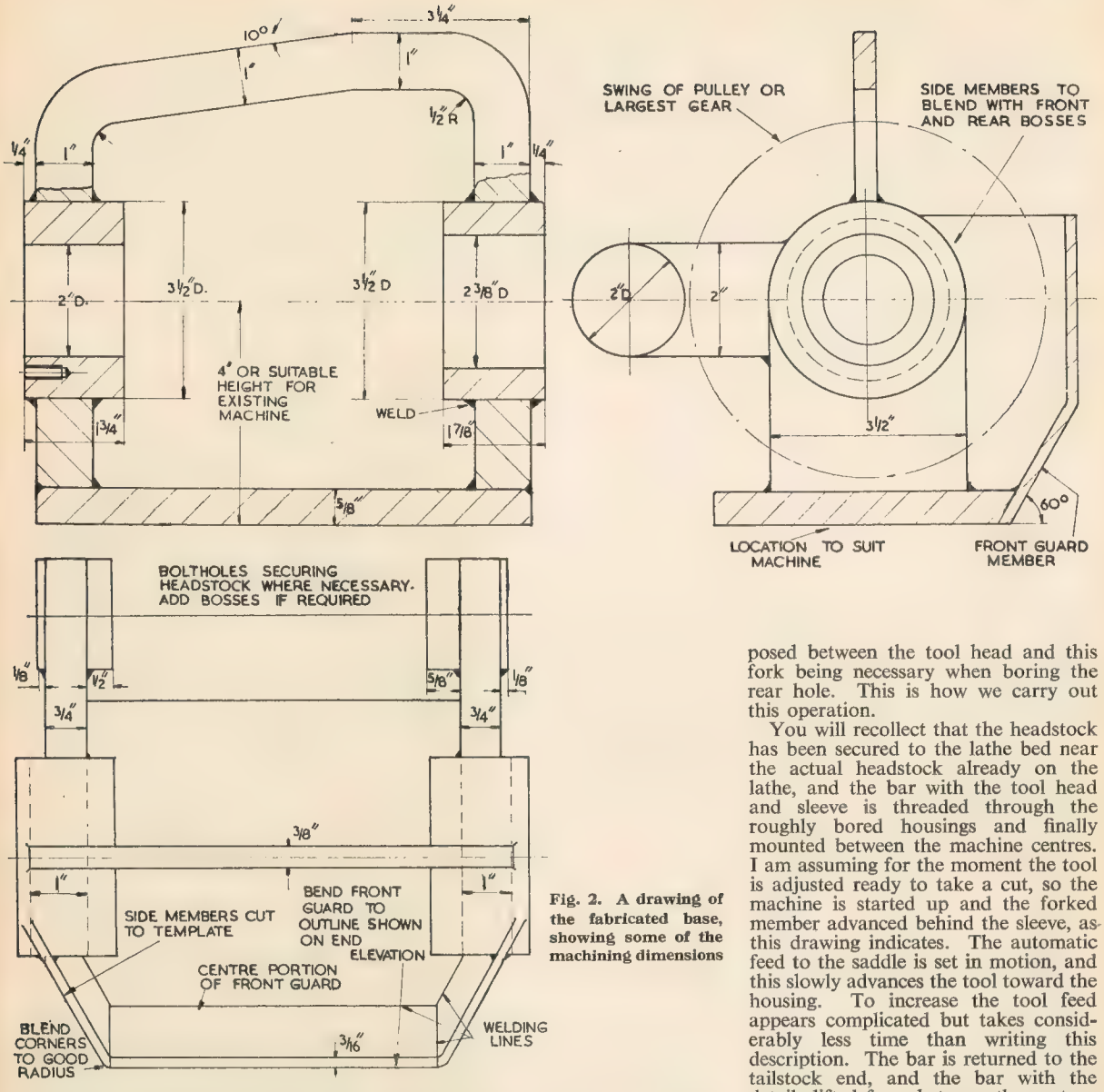


Fig. 2. A drawing of the fabricated base, showing some of the machining dimensions

this setting should give the exact centre height.

Boring these holes is a little unusual, though it follows closely previous ideas described in THE MODEL ENGINEER for similar work. The drawing Fig. 3 illustrates a ⅜-in. dia. bar which is accurately centred, and has a keyway machined to prevent the tool head rotating under pressure; while a flat filed at one end is used to take the drive from any suitable carrier.

Because space is a little restricted, only a very small tool is possible, but this, when clamped tightly with a socket-head grub-screw, will not move, as the depth of cut is kept within reasonable limits. The maximum amount of material has already been machined away during the roughing stage, so there is no need to apply heavy cuts again—about 1/32 in. until the correct diameter is reached is ample, and does not cause the tool to push back into the head.

Incidentally, as there are two different diameters in this headstock, 2 in. and 2⅜ in., two tools of varying lengths are preferable, or, of course, one could make the rear bush larger and bore holes of both the same diameter through the housings. However, this is a matter where you can please yourselves; it will not affect the design.

The feed motion to this boring tool is obtained from the forked member, which is attached to the tool box on the cross-slide—the sleeve seen interposed between the tool head and this fork being necessary when boring the rear hole. This is how we carry out this operation.

You will recollect that the headstock has been secured to the lathe bed near the actual headstock already on the lathe, and the bar with the tool head and sleeve is threaded through the roughly bored housings and finally mounted between the machine centres. I am assuming for the moment the tool is adjusted ready to take a cut, so the machine is started up and the forked member advanced behind the sleeve, as this drawing indicates. The automatic feed to the saddle is set in motion, and this slowly advances the tool toward the housing. To increase the tool feed appears complicated but takes considerably less time than writing this description. The bar is returned to the tailstock end, and the bar with the details lifted from between the centres. The head is held in one hand while the special long screw I have drawn is quickly screwed into the tapped hole immediately behind the tool. If the screw holding the latter is very gently released, only enough to allow the adjusting-screw to push it forward, the initial setting is not easily disturbed. A final tighten of this socket grub-screw, and the tool head is once more ready for a further pass through the bore—the special adjusting member is naturally removed before the bar is placed in the centres.

The boring of the rear housing is performed in this manner, but perhaps a longer sleeve is needed, as the forked rod cannot advance past the front housing. A piece of black bar with a

25/32 in. hole drilled through the centre takes but a few moments to make—in fact, if one has several derelict pieces in his scrap box, then one can use these instead—it takes only a moment to assemble them.

The tool is a short length of silver-steel, and this should present no problem; while if the long bar is made from bright material, this saves some considerable turning time. Finally, the forked member is also an item which you can alter if you think this necessary—perhaps even a straight bar pressing on just a small area of the sleeve will prove satisfactory, but please yourself. I used the forked end because I had one already available when I applied the same idea to some other type of casting a few months ago.

For the benefit of those who seldom have the opportunity to visit an engineering workshop, perhaps I should explain that the practice of packing up the headstock and tailstock of a lathe, or for that matter other machines in a similar way, is not new. I have on numerous occasions almost rebuilt the machine in an effort to carry out a special operation on a component, and though the cost is rather high when the work is first done, many engineers prefer such tactics, because the firm in question can then go ahead without fear of delays which might occur if the article is sent away for machining. However, I consider the method I have shown in this article meets the needs of most readers, and though the first impression is that there is a fair amount of work involved in making the parts, the boring bar is not really a formidable one, and well within the scope of a comparative newcomer. The crux of this design is the fit you must achieve between the bar and tool head—a perfect slide is essential and this will ensure both holes are perfectly in line.

The final operation of boring the backgear hole is performed by drilling and reaming, using either an edge or the underneath location which positions the headstock as a setting medium. These holes are not so important as those for the headstock spindle, though you must endeavour to maintain the centre distance as a plus dimension, and so make certain the gears can mesh properly. If the holes are turned end to end, and reamed with a short stub reamer, then the back gear shaft should lie parallel with the spindle bore. An error of 0.002 in. or thereabouts is of no consequence, and I doubt whether this will create excessive rattle of the gears.

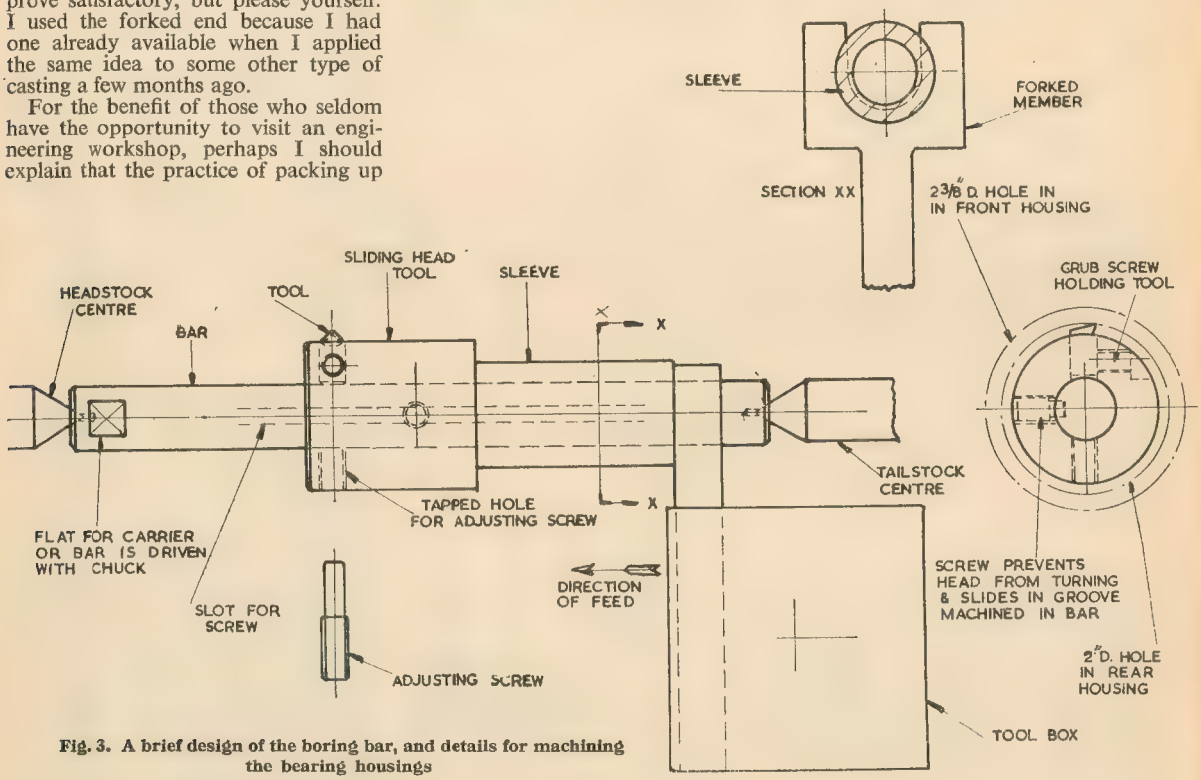


Fig. 3. A brief design of the boring bar, and details for machining the bearing housings

Facing the Bearing Housings

Some may contend that the scraping all over of the bottom face of this headstock is not really necessary, but I think you may have to do this if the lathe bed on which you bored the holes has worn slightly. So set up the headstock, and with a suitable plug inserted in the front housing, check the exact centre height with the aid of a dial indicator. An identical operation is performed on the tailstock, and a comparision of the result will reveal which needs this adjustment. I imagine the headstock may need slightly scraping—say, 0.001 in. of the face to bring the hole in alignment, but before doing this, the facing of each side of both housings is essential, and how you carry out the work is a matter of personal opinion.

I would prefer to do this while the headstock is clamped to the bed—in fact, before any attempt is made to release the clamping bolts, so for this process a new bar with blade cutters is required, and both orthodox and back facing is needed to complete the work.

You could, of course, face these housings on a shaping machine—passing the tool across each surface while the headstock is securely held on the table, but a very careful setting is essential to make sure the spindle hole is at right-angles to the machine ram. If the reader is facing them in this way, then the previously mentioned edge against which he can push the headstock while the tool takes the necessary series of cuts is an ideal setting medium. By this means the facings do at least stand a good chance of being square with the bore—an important feature, as the bushes must assemble correctly.

If the boring bar method is preferred, the tools are easy to make, being simply flat pieces of hardened high-speed steel, but the user must keep them sharp if he expects them to cut a flat surface. Each facing is thus rough-machined, and then the tool is reground prior to the finishing cut being applied.

Another point which I have intentionally omitted from these drawings is any arrangement for the location of this

(*Continued on page* 691)

The S.S. "Robert Allen"

THE STORY OF AN 8-ft. RADIO-CONTROLLED CARGO LINER

By Ivan P. Millar

IN course of time, the engine was finished and, on air test, worked quite well, only to be an ornament on the mantelpiece for more than 30 years. As related, it was "spotted" for use in the projected ship and was critically examined in the light of experience. It was found to be fundamentally sound, but required some minor but important modifications, so proper bronze die-blocks were made for the links, the cut-off reduced from about 80 to 65 per cent. long, addition of outside lap to the valves and the angle of advance of the eccentrics amended to suit. The steam clearance of the pistons was reduced by skimming the covers, and new steam and exhaust manifolds made to suit the new layout. The valves were set under steam, using the sound of the exhaust and ability to start from all positions as guides to performance.

As the ship was well advanced it was then possible to instal the engines in the hull and run a test in a wet dock made for the purpose. The first test was arduous, and the plant was run for seven hours, before stripping for examination. The engine, beyond adjustment of glands, needed no attention and has since required the main bearing and big-ends to be taken up but once.

A condenser was fitted to conserve distilled water from the exhaust and to dispose of the steam which would otherwise, rather unrealistically have to be discharged up the funnel. (No idea was entertained regarding creation of a vacuum as the complications were considered not worth while.) The engine exhausts, via a centrifugal type oil separator, about 2 in. dia. × 2 in. high, which discharges oil and water over the side of the ship, to a condenser made from some fifteen 18-in. lengths of $\frac{5}{16}$-in. copper tube set serially between two headers, one header taking the exhaust and the other delivering the condensate to the hot cock described. The condenser lies under the floor of the ship between two $\frac{3}{4}$-in. × $\frac{3}{4}$-in. rubbing strakes and despite neglect both internal and external still passes no steam. Some oil inevitably passes through to the hot cock owing to a very liberally rated "L.B.S.C." pump, but the filter takes care of that quite well, otherwise, evidence would soon be showing in the gauge glass and by priming: the back pressure on the exhaust is quite small, being of the order of 9 in. water or a mere fraction of 1 lb. per sq. in.

Continued from page 661, *June* 9, 1955.

Lubrication

The lubrication of an open-type quick revolution engine is, to say the least of it, messy and perhaps not altogether satisfactory. In *Robert Allen*, reliance is placed, at the commencement of a run, on a good swab down all over with black cylinder oil, and a squirt round the bits and pieces with a pump type oil can. Fortunately, the ahead direction of rotation carries most of the emulsion so formed out of the sump up to the crossheads, etc.; but a lot gets thrown out, necessitating a shield over, amongst vital things, the reversing motor. The big-ends get enough apparently via the drilled connecting-rods, whilst the main bearings and valve-gear get a full share of what is thrown around!

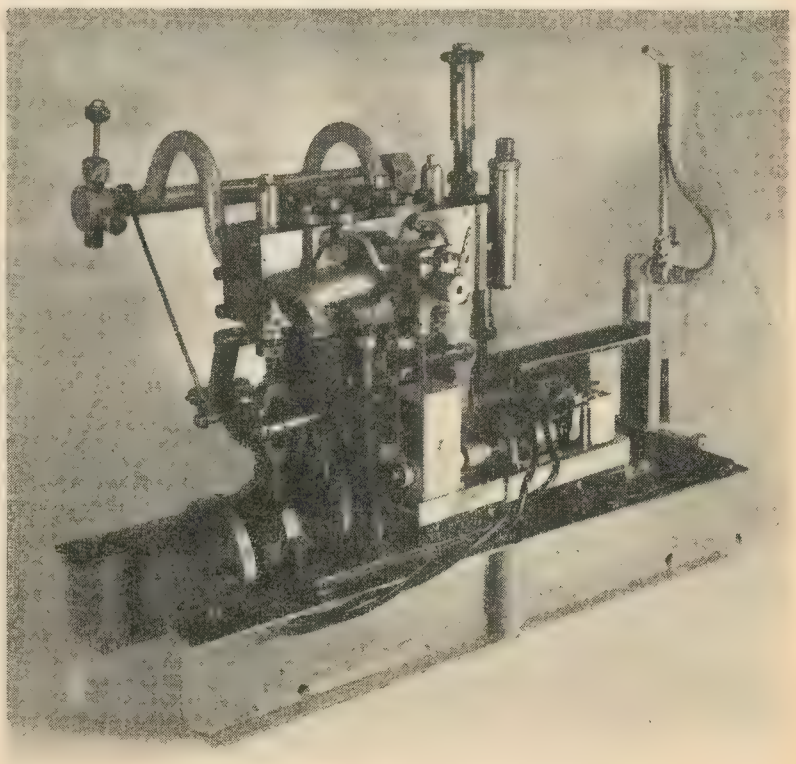
When running, the oil pump, $\frac{1}{16}$ in. × $\frac{1}{4}$ in. stroke, made to L.B.S.C.'s "words and music" takes over, being driven by a rod from the aft valve-gear, and although the bulk of the oil passes out with the exhaust steam, enough passes *via* glands to the motion to give adequate service.

The pump delivers into a pipe leading to the undersides of the branches from the steam header to the valve-chests.

Boiler Feed Pump

As stated before, the vertical feed pump has a ram 5/32 in. dia. × $\frac{1}{2}$-in. stroke. The ram is of phosphor-bronze and $1\frac{1}{4}$ in. long and is driven by an eccentric from the forward end of the engine. The pump, complete with stainless steel ball valves of very small lift, is bolted on to the forward valve-chest, being heat-insulated therefrom by a 3/32-in. shim of Paxolin intended both to keep the pump cool and the valve-chest hot.

The output of the pump is not regulated by the usual by-pass valve but by means of another 5/32-in. dia. × $1\frac{1}{4}$-in. long ram in its own body located immediately over the main ram and directly coupled by a water way to a point between the suction and delivery valves.



A view of the engine with reversing motor

The free ram is spring-loaded and its travel is adjustable by means of a screwed cap ($\frac{1}{4}$ in. × 40 t.p.i.) which limits, as desired, the distance the free ram may retreat during the pumping stroke of the main ram. From this, it is obvious that if the free ram be held hard down by the screwed cap, the whole of the water from the main ram must pass to the boilers; but if the free ram be allowed to retreat against its spring by unscrewing the cap a full $\frac{1}{2}$ in., no water will go to the boiler. Proportional delivery will be given to the boiler, depending on how far the cap is screwed down.

It will be apparent that the amount of steam (or water) taken by the engine per revolution will depend on boiler pressure, r.p.m., amount of throttle opening, etc., and therefore no one setting will be correct at all times. In practice, however, in *Robert Allen*, it seems that the average steam demand works out fairly well, resulting in acceptable but small variations in water level in the boiler. The system appears to be preferable to the by-pass method where the amount delivered by the pump at a fixed setting of the valve varies enormously with pump or engine speed. This might be acceptable to the locomotive man with the control under his hand, but it appears not to be so good with a ship which for quite long periods is away from the engineer (especially with radio control).

In passing, it might be said that the strength of the free ram return spring is not critical, but should be enough to return the free ram quickly to its zero position and yet not so strong that the free ram is held down, thus delivering all water to the boiler when the boiler pressure is low.

At up to 1,000 r.p.m., the pump is fairly quick-acting, and to avoid the friction and inertia of the water in the long pipe from the hot well, an extra small feed tank is provided immediately under the feed pump with an air-vent to high level.

The delivering pipe to the boiler was an air cock at the highest point which serves as a test cock as well. Once primed, the free ram can be heard tapping quite clearly, a comforting sound both before and after a long run.

Burners

As we had neither data on hand nor experience concerning making straight paraffin burners, we thought it a good idea "to start where the other fellow left off" and examine a number of commercial types, and then make a couple to suit our own purposes, bearing in mind they would have to fire vertically downward into closed combustion chambers. Some half-dozen were looked at and, so far as could be seen, had no common features other than the possession of jets, vaporisers and induction tubes, and being made of brass. With most of them little jets of flame shot out of holes in the sides of the tubes; some had fancy air slots and changes in diameter; some had cast vaporisers, and some tubular, either inside or outside the induction pipe. So we were little nearer a solution.

It had already been decided that induction tubes would be about $1\frac{1}{2}$ in. dia. if all the air required was to be got for combustion without the addition of secondary air—more or less an idea really, but once settled upon was adhered to. The length of the tube could not be guessed so we decided to set up a test jet and measure it: to do this a primus tank was commandeered and provided with a copper pipe coil terminating in a medium size of standard jet or nozzle. The coil was separately heated by a gas flame. The vapour jet was clearly visible, so long as there was no superheat, and so was directed across a dark background, and found to contain an angle of about 10 deg.

With a $1\frac{1}{2}$-in. dia. induction tube, a narrow jet like that would have to travel about 10 in. before striking the interior and inducing air flow, thus making a burner almost a foot long, long enough to reach almost half the way up the funnel if placed vertically! As this could never be, something had to be done about it, and the happy idea of using a "spreader" occurred. It was recalled, too, that the vapour air mixture weakened as the column moved away from the nozzle, and flame travelled more quickly through a mixture as it weakened (up to a point, of course), so that a stage was reached when the forward speed of the mixture equalled the backward speed of the flame when combustion would be steady there. So the idea was got to place the "spreader" in such a place that combustion occurred where it was wanted, and that at that point would we put the vaporiser. There then seemed no reason why the "spreader" should not also be the vaporiser as well!

The test nozzle gadget was got to work again, and various sorts and sizes of obstacles were placed in the way of the vapour steam including lots of straight rod. Then it was found that a barrier about $\frac{5}{16}$ in. dia. served nicely to split the jet of vapour to fill a $1\frac{1}{2}$-in. tube at a distance of $3\frac{1}{2}$ to 4 in., and various sketches were made to work this fact in. The design selected uses 4 in. of $1\frac{1}{2}$ in. × 18 S.W.G. brass tube, enclosing a single U-tube "spreader" of $\frac{5}{16}$-in. dia. copper tube brazed into a brass head and fitted with a medium size blowlamp nozzle.

In making the first burner, a $\frac{1}{2}$-in. length of $1\frac{1}{2}$-in. brass bar was parted off and a $\frac{1}{4}$-in. drill run across the diameter to a point just past the centre, and also in at the other end of the diameter for $\frac{3}{8}$ in. The latter was enlarged to $\frac{3}{8}$ in. dia. to receive the male part of a union and the other fitted with a plug $\frac{3}{16}$ in. thick. The burner head so produced was drilled in the centre and tapped $\frac{3}{16}$ in. × 40 t.p.i. for the nozzle. Two $\frac{5}{16}$-in. holes were then drilled on either side of the nozzle to just break into the $\frac{1}{4}$-in. holes mentioned, to receive the ends of the U-tube. The U-tube was made from a 10-in. length of $\frac{5}{16}$-in. light-gauge copper tube, being soft-solder filled, bent on a wood former to a radius which enables the U to slide nicely in the $1\frac{1}{2}$-in. tube. The U was then emptied of solder, cleaned up and cut to a length of $3\frac{3}{4}$ in. plus $\frac{3}{16}$ in. to enter the holes in the underside of the burner head. It remained to "B6" all the parts together, add the air tube and fix this with two 4-B.A. screws after $\frac{3}{4}$-in. × $\frac{7}{8}$-in. air-holes had been cut in the sides near the top. (It transpired that the nozzles were not screwed quite $\frac{3}{16}$ in. × 40 t.p.i. as thought, but after adjustment with a die, screwed in and proved quite tight.) On test the burner gave a lilac coloured flame about 9 in. long with approx. 30 lb. per sq. in. pressure after the nozzle had been opened out slightly with a fine brooch. Sleeves for air adjustment were fitted to cut the supply by 50 per cent., if needed, but were found to be unnecessary and were abandoned. The design has remained unaltered since that date and all burners made to this pattern continue to work equally satisfactorily.

It was feared that the copper U-tubes would have worn thin owing to flaking due to oxidisation and that brass tubes would have been a better choice. But so far, so good.

The burners were provided with 5-in. special coils of $\frac{1}{8}$ in. copper tube as supply pipes, attached to the boiler casing, so that the burner head could be lifted out for servicing without the necessity of parting a union. "After all," we had thought, "the rate of flow would be frightfully small and $\frac{1}{8}$-in. tube would, of course, be big enough." But it was not to be, because, as soon as a burner was started up, we were disgusted to find it surged frantically. Repeated trials with one or the other showed that at low pressure the surge was slow and violent (about 1 per sec.) but as the pressure was increased the surging became quicker and less violent but never died out entirely.

This meant the end of the spirals and direct 3-ft. long runs of $\frac{3}{16}$-in. pipe were substituted, but still surging took place. So, out came the $\frac{3}{16}$-in. pipes in favour of $\frac{1}{4}$ in. dia., but the trouble, although less pronounced, still persisted. Being persistent ourselves, we tried $\frac{5}{16}$-in. pipes (big enough, we thought, to feed a burner as big as the ship) and the trouble disappeared except at very low pressures. The addition of non-return valves next to the burners finally did the trick and, although it was felt that the root of the trouble was not found, we were content to leave it at that for the time being.

Instead of going to the trouble of trying bigger and yet bigger pipes, a moment's thought would have given the answer, as was to be the case a year or two later, when the matter was again

reviewed. The cause of the surging was obviously due to the paraffin, on arrival at the hot burner, flashing into vapour with a big pressure rise, and as a consequence thrusting the paraffin back to the tank until the pressure was dropped by the vapour escaping through the jet. When the tank pressure was again able to do so, it pushed more paraffin forward and the flashing occurred again, and "ditto repeato" as our venerable "L.B.S.C." might say. The surging would, of course, be authorised by friction of the paraffin in the small-bore piping, especially when of considerable length. As a result, small antisurge tanks were made and installed within 3 in. of the burners, retaining sufficient of the $\frac{5}{16}$-in. pipe to form connecting pieces. The tanks were made from light-brass tube 1 in. dia. × 5 in. long with end discs silver-soldered in place. Both inlet and outlets are at low level, thus trapping air in the upper positions to act as cushions.

On test, the burners, with the original $\frac{1}{8}$-in. pipes reinstalled, operate quite steadily at all pressures.

The semi-permanent fixing of the burners raised the problem of starting them up and, as the usual methylated spirit cups were not practicable, resort was had to a hand blowlamp which was effective, although there was a risk of damaging surrounding paintwork on the superstructure. Another thing, when standing in the water there was no place to put it when finished with; besides, it is an awkward object to hand to anyone, etc. So, to be very clever, it was decided to provide small bunsen burners in the tops of the big ones and supply them with calor gas from a bottle to be carried on one's person.

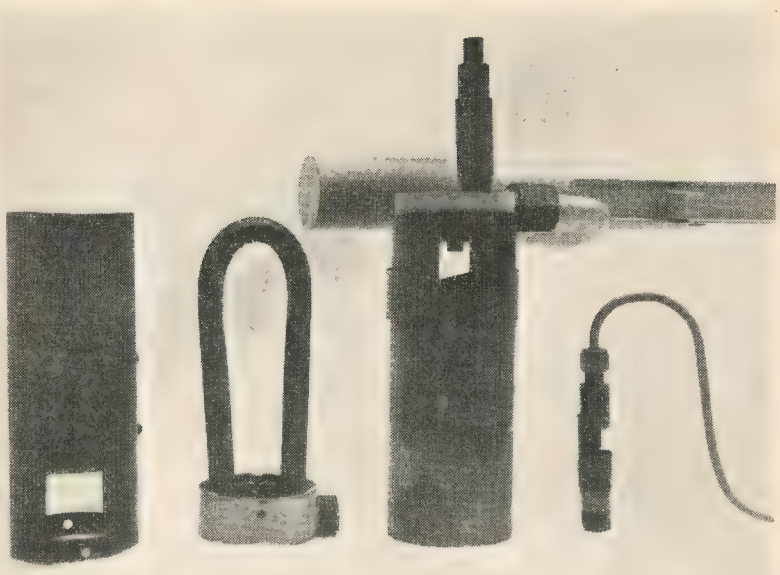
The gas burners were made from $\frac{3}{8}$-in. brass tube $1\frac{3}{4}$ in. long fitted with end plugs carrying unions for $\frac{1}{8}$-in. pipe on top and the smaller and calor gas jets underneath. The tubes were cut away a half diameter for $\frac{7}{16}$ in. for air to enter. Two saw cuts $\frac{1}{16}$ in. apart up the lips gave tongues which were bent into the mouths to form "spreaders" as adopted in the paraffin burners.

The main burner heads were drilled $\frac{3}{8}$ in. to receive the gas-burners, and the $\frac{1}{8}$-in. pipes for the gas were carried away to needle valves on a $\frac{3}{16}$-in. common gas supply pipe. The flames play downwards on to the vaporising U-tubes of the main burners.

Gas is supplied from a bottle carried on a belt at waist level, by a special rubber tube to the ships side where connection is made to the internal piping in the ship.

Electric gas lighters have yet to be installed!

Starting now is trouble free, but methods and caution is advised. Experience soon teaches one to avoid filling the combustion chambers and probably other confined spaces in the ship with a mixture of gas and air, as this, upon ignition, is liable to cause "alarm and despondency" in the onlookers and possibly the loss of one's eye-brows, front hair and glasses (if any), and certainly one's composure. One of us can, with attendant blushes, call to mind having to take violent evasive action by plunging in the lake to avoid cremation when separation of the rubber supply pipe caused a flare-up of gas and burning liquid. But, as stated, the gas burners are trouble free if carefully used.



Burner with antisurge tank; also, "exploded" burner

Speaking of fire, paraffin is comparatively safe in use; witness the fact that, if one should inadvertently have both fuel valves open when starting only one, thus pouring neat paraffin straight into the combustion chamber with the other, all one has to do to extinguish any resultant fire is to place one's hat on the funnel.

Below the forward well deck lies the paraffin tank, constructed of 18-S.W.G. solid-drawn copper and $3\frac{1}{2}$-in. dia. × $10\frac{1}{2}$ in. long with 16-S.W.G. flanged copper ends brazed in with "B.6." No longitudinal stays are fitted as it was reckoned the tanks would stand 100 lb. per sq. in. without any, the working pressure being 35 lb. The effective fuel capacity is about $2\frac{1}{2}$ pints and gives roughly 3 hours running.

Frankly, the construction of a hand-pump was evaded because of the fancied difficulty of getting the foot valve tight, and a commercial pump was bought instead. This was silver-soldered into a petrol can filler cap and a screwed column made to accommodate it on the fuel tank.

Arranged also on the tank are two angle stop-valves to control the paraffin to the burners, together with the automatic unit with it's own angle stop-valve, a pressure gauge and own air release screw. To facilitate fixing, a $\frac{3}{8}$-in. tube was run down through the tank to permit the passage of a $\frac{1}{4}$-in. holding-down bolt which screws into a heavy plate attached to the floor of the ship. Bent sheet brass feet completed the job. (No full stop valves are large enough for $\frac{5}{16}$-in. pipe unions but, as already shown, could be much smaller to take $\frac{1}{8}$-in. piping.)

Automatic Burner Control

Although some 5 min. steaming on full burners can be done before the water level in the boiler falls to the "bottom nut" on the gauge glass, the prospect of the propeller getting fouled with weeds and so stopping the engine-driven feed-pump was viewed with some alarm; hence the adoption of the auto-control.

(To be continued)

MINIATURE ELECTRIC MOTORS

Most of our readers are familiar with the miniature electric motors manufactured by Victory Industries (Surrey) Ltd., Worplesdon Road, Guildford, and used in scale models of British cars and industrial equipment. These products attracted considerable attention at the British Industries Fair, Olympia, where the latest types of models were exhibited, including several of the most up-to-date cars, the Leyland "Comet" Tipper Truck and the "Conveyancer" Fork-lift Truck, all in 1/18 scale. The "Mighty Midget" electric motor which supplies power to all these models weighs only 1.3 oz. and is $1\frac{3}{16}$ in. high; it runs at a speed of four to six thousand r.p.m. on 3 to 6 volts d.c. and is reversible by changing over polarity of supply. A detailed article on this motor and the various types of models in which it is fitted was published in THE MODEL ENGINEER, dated February 11th, 1954.

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

A CANADIAN READER'S WORKSHOP

DEAR SIR,—I trust you will find this photograph of my workshop worthy of publication in THE MODEL ENGINEER. I am very proud of this shop, because it has taken years to get it organised as I wanted it.

I live right down-town here in Toronto and I am a member of the Toronto Society of Model Engineers. When I bought this property 12 years ago, I was pleased to find that the garage was very large, 40 ft. square. I owned several cars (sports and antiques), and I was very happy, but my model shop was a block away, in my parents' house, and that made a complication, as I longed to have everything under the one roof.

Last spring I made the change, sold five of my cars, and rebuilt the garage to give me a model shop, 18 × 40 ft.

The picture shows my big plate glass windows to the south, so that I get lots of sunshine, although on the day the picture was taken it was snowing heavily. The panelling to the left is a toilet, and the panels were salvaged from the steamer *Kingston*; all the walls are painted pastel green and the floor is just natural wood.

As to models, my preference is the glass case type of boat; on the draughting table you will see one of my best, and the other photograph shows it more clearly (with the case removed).

I have arthritis, and so must sit down to work, hence the piano stool at the lathe. I keep many of my fine tools, on the white medical table, a scheme other model-makers could well use; I keep a cloth on the table, then the fine tools don't roll off. The table moves very easily (at a touch), so it saves a good deal of moving around.

My shop is heated with an oil space heater, fed by a 200 gallon tank in the other part of the garage. On the right of the picture is a large mirror (it looks like another window); note the soda-acid fire extinguisher, and the lights let in the ceiling. I think I have as good a shop as anyone could wish for.

Yours faithfully,

J. GORDON EDINGTON.

Toronto, Ontario.

MILL ENGINES

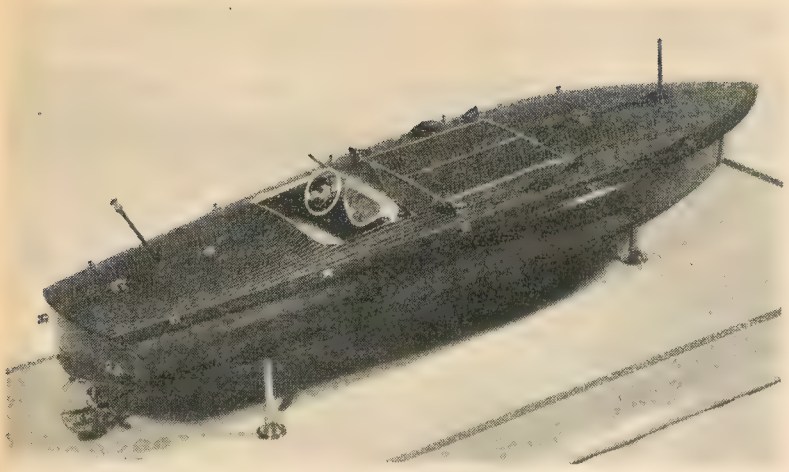
DEAR SIR,—With reference to the meagre description by Mr. G. Gardner of his magnificent model of a mill engine in the May 19th issue; I was hoping for a close-up view of the valve-gear and a detailed description of how it was possible to scale down this piece of interesting mechanism. To me it clearly resembles the Dobson motion which incorporates a dashpot arrangement to ensure a snappy return of the valve to the shut position after it has tripped.

I spent some time in admiring the photographs, I like the absence of overhead steam pipes, the completion of the engine by the installation of the condensing plant and the "banjo" lubricators to the crankpins.

In THE MODEL ENGINEER we see far too many examples claimed to be mill engines by their builders, just because they are horizontal. May I stick out my neck and say this includes Mr. E. T. Westbury? Most engines described as mill engines would be better described as small workshop engines.

Having worked as an apprentice with a well-known firm a few miles to the north of the first two mentioned in the article, I feel a little entitled to voice an opinion regarding mill engines, as they were at one time the chief business of the firm, together with their boilers and mill gearing.

Having delved into the "hidden mysteries" of full-size engines I hope Mr. Gardner will not consider me too presumptuous regarding the following comment. In full size the flywheel would be about 25 ft. in diameter, about 80-90 tons in weight, approx. 6 ft. face and 25-30 rope grooves. Ten or twelve spokes would be cottered



One of Mr. J. Gordon Edington's glass case model boats

to the hub. To overcome this in model practice it would be simple to reduce the thickness of the rim and fit the usual boarding found in full size to reduce loss of power, also noise caused by windage. See cover of March 31st issue for details of scribed lines to simulate joints.

One final point, it will be appreciated that in full size, the l.p. piston is quite some weight, and is usually supported at each end of the cylinder, i.e., by crosshead, and a slide in between the two cylinders; also, the h.p. piston occasionally is supported by a tail slide depending on size and weight.

I feel sure that Mr. Gardner is to be congratulated on a magnificent model and for showing the vast majority of readers what a mill engine really looks like. Thank you Mr. Gardner.

Yours faithfully,

Manchester. J. WILKINSON.

5-in. GAUGE ELECTRIC LOCO

DEAR SIR,—May I, as one who helped to build the L.M.R. locomotive as described by Mr. R. Turner in a recent issue of THE MODEL ENGINEER, reply to Mr. S. B. Whitmore. According to his statement, his locomotive has been tested with two adults only, one trolley and 20 ft. of track. The L.M.R. 10000 was asked to pull 16 children on four trolleys on a 200-ft. track for hours at a time. This locomotive was a team effort by the club members, some of whom were well aware that under the above conditions there would be serious slipping, as out of a total of twelve wheels, only four were driven. These were not sprung, but the other eight were spring-mounted, and would, therefore, take most of the weight.

My own personal effort built in 1953, a 5-in. gauge electric locomotive, total weight of only 50 lb., driving six sprung 3-in. drivers, pulls five children under adverse conditions, viz.: bad weather, rough track, and heavy gradients. On a continuous track, and given reasonable conditions, it will pull eight children on two trolleys. My locomotive was designed to run on an existing steam track. The rails being on wooden sleepers, I used the 3½-in. gauge rail for pick-up for convenience, and others, no doubt, have done so.

Yours faithfully,

Maidstone. C. E. HOOKER.

DRUMMOND LATHES

DEAR SIR,—Your correspondents "Novice" and Mr. H. G. Harrison may be interested to know that the similarity between the Drummond "B" and "M" type 3½-in. lathes is even greater than is suggested by the latter.

When the "M" type was introduced in 1919, it was generally as the present "M" type, but had a ⅝-in. dia. leadscrew with solid leadscrew nut, and was not fitted with the apron, or with the rack and pinion traverse. The larger diameter leadscrew and the improved features were not fitted until 1924. Again, the heavier pattern top-slide with the integral spigot were not on the earlier "M" machine, though this top-slide may have been introduced prior to the fitment in 1924 of the other features mentioned.

Another minor correction is that with the introduction of the "M" type lathe the diameter of the tailstock barrel was increased from ⅝ in. to ¾ in. Incidentally, it is often suggested that the only reason why the present "M" is fitted with a clutch is because when first introduced it was in effect a modified "B" lathe, and, as indicated above, had a solid leadscrew nut, thus necessitating this feature.

Yours faithfully,

Chilwell. R. L. G. LOWNDES.

AN ALL-FABRICATED LATHE HEADSTOCK

(*Continued from page* 686)

headstock in line with the machine axis. This is a matter the reader must settle for himself to suit his own particular requirements, and if a strip is dowelled and screwed to the bottom face before boring, it will serve instead of the machined edge. However, this is so obvious that I did not think it worth more than a cursory mention.

Next is the question of normalising this body to prevent any subsequent distortion taking place, and this is, I am afraid, somewhat outside the scope of the usual home workshop. In the large engineering tool rooms, the fabrication of jigs and fixtures is often carried out with success, and here again there are many firms who also do not possess the facilities for this treatment. If the headstock was cast, there is also the possibility of that material distorting, but I think readers need not become unduly worried over this item, because with the overhead arm, the massive bearing housings and the front plate tying the two members together, the risk of any movement is negligible. Jigs and fixtures are usually rough-machined and finished within a week, and seldom do the bases and bodies warp if they are properly ribbed, and not too many large apertures cut from the main details.

For those who have the countershaft behind the lathe, and who would like to construct this headstock, the connecting bar in the present position may create an obstacle. Thus some modification is essential, and for this I suggest you move it round say 30 or 45 deg.—perhaps lowering the front guard or moving it to the back in the process. The belt will then clear, and the new position will not in any way affect the working qualities of this accessory.

In the following instalment, I propose to give some dimensional drawings of the bushes and bearings, with a few notes on how to make them, so I will just say that I expect criticism of this design and I welcome it, because only by constructive effort can we advance the hobby of model engineering. Many will look upon a fabricated headstock with horror, but I know it will work satisfactorily once the teething troubles have been overcome, and it will not take so long as the making of a pattern.

(*To be continued*)

QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:
(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Cutting Steam Ports

Can you please tell me the correct way to cut steam ports in valve faces, so as to get a clean straight edge to port bars and ports? I have been trying to cut some ports 3/32-in. wide, but find that the very small cutters do not produce a clean edge to the port. Should the cutter be fed into the valve face like a drill, then withdrawn, the work slide traversed, and the cutter again fed into the metal, or should it be traversed backwards and forwards along the whole length of the port until the required depth is obtained? As an alternative, would it be practicable to make a false valve face out of $\frac{1}{16}$-in. gunmetal, and after filing the ports to the required size, solder this to the valve face?

H.W. (Harrogate).

The method which you suggest is that most commonly employed by model steam engine constructors, but it is necessary to mount the cylinder either so that vertical adjustment can be obtained to locate the ports at the right height, or alternatively, some method of packing up to the required height may be used.

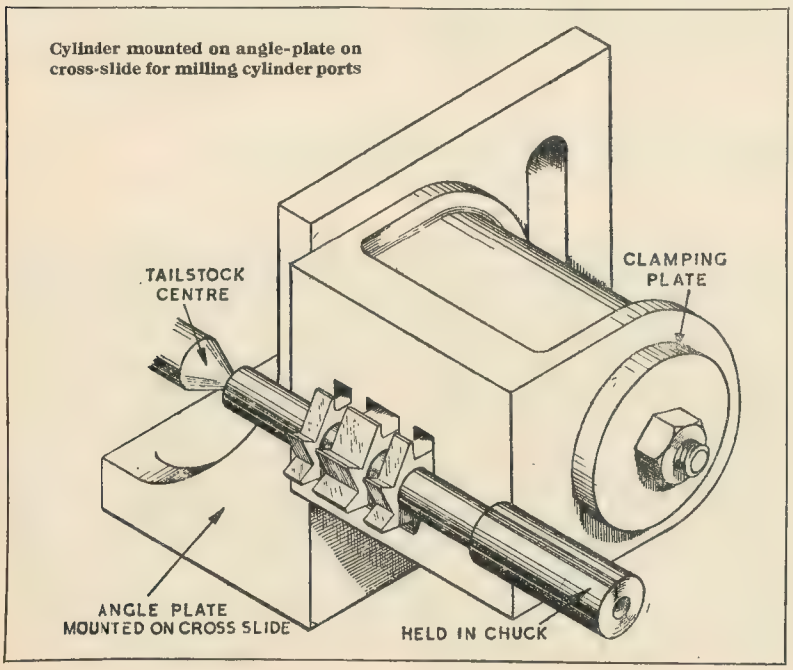
When using very small end-mills for cutting ports, it is necessary to run the spindle as fast as possible, and on no account should the cutter be expected to take very deep cuts.

The best and most accurate results are obtained by feeding inwards a very small amount at a time, and traversing along the length of the port. If the cutters, when used in this way, fail to produce port edges, it indicates either that there is excessive play in the spindle bearings or the lathe slides, or that the work is not sufficiently rigidly mounted.

An alternative method of cutting steam ports, which has been fully described in THE MODEL ENGINEER, is that in which side milling-cutters are used to produce ports which are crescent-shaped in end section. This gives perfectly clean rectangular ports, though the depth is necessarily limited. This method was described in the issue of THE MODEL ENGINEER dated July 16th, 1953 in conjunction with articles on Utility Steam Engines.

With reference to your suggestion to cut a false port face and file the ports in it, this has been done in many cases, but the use of soft solder for attaching the false port face is not permissible when high pressure or superheated steam is used and is not generally favoured by model engineers.

Cylinder mounted on angle-plate on cross-slide for milling cylinder ports



Secondary Electric Clocks

I wish to obtain a number of slave clock movements, to make up a time-keeping system in connection with a master clock.

The specification for the slave clocks should include the hands, necessary gearing for these, the electro-magnet assembly and associated impulse wheel, preferably for one minute impulses. I wish to provide my own cases.

Do you know of any firm who supply such things in small numbers of whom I might make enquiries?

L.E.P. (London, N.14).

We presume that what you really mean is secondary clocks, as slave clocks are quite distinct, and do not agree with your description.

Most of the firms who manufacture electric timekeeping systems can supply secondary clocks, but we gather that you wish to buy the component parts of these, and the only firm we know of who supply such components is the Synchronome Co. Ltd., Abbey Works, Mount Pleasant, Alperton, Middlesex.

Voltage Discrepancy

I have obtained a 1/3 h.p. motor rated for 240 to 250 volts and the voltage of my domestic supply is only 210 volts, I should be glad to know whether it would be inadvisable to run the motor on this voltage. If so, can you please give me particulars of a suitable auto-transformer to step the voltage up to 240 volts?

M.F. (Bristol, 4).

No harm whatever need be anticipated to the motor by running it on the lower voltage, but it will necessarily give slightly less power than on its full rated voltage.

We do not consider that it would be necessary to use a transformer to step up the voltage to 240 volts. Details of transformer windings are not within the normal scope of our Queries Service, but our handbook "Small A.C. Transformers" price 3s. 6d. would be helpful to you in this respect.

Next Week . . .

AN ELECTRONIC STROBOSCOPE
Constructional details of a valuable instrument for high speed mechanical research work.

NOTABLE I.C. ENGINES
Describing the Attwood "Champion," a high-efficiency two-stroke by one of the best-known American commercial designers.

ROTARY PUMPS AND MOTORS
This instalment deals with typical examples of modern centrifugal pumps.

A REVERSING SWITCH
"Duplex" describes the construction of a simple form of switch for motor control and similar purposes.

"NETTA"
Many of the components that are included in the make-up of a locomotive must be operated directly by the driver. The necessary footplate wheels, handles, gauges and so on, are described for the 2½-in. and 3½-in. gauge engines.

WITH THE CLUBS

The Society of M. & E.Es.

The society will meet informally at Caxton Hall, Victoria Street, Westminster, on Thursday evening, June 23rd, for discussion on matters of common interest, for which purpose members are asked to "bring something." The novice, in particular, is asked to comply with this request, and if these notes should catch the eye of the lone-hand, he is assured of a cordial welcome to this meeting and if he wishes, to bring some examples of his work.

Members are again reminded that Thursday meetings have been arranged to meet the needs of those who find normal arrangements difficult.

Secretary: S. L. SHEPPARD, Third Floor, 11, Portland Place, London, W.1.

March & District S.M.E.

The March and District Society of Model Engineers has been revived. On being appointed to the staff of the Hereward School, March, the writer was asked if he would be willing to run an evening class for model engineers, and decided to do so.

When the class started many of the "students" were men who had been members of the old March and District Society of Model Engineers, which for some reason had folded up.

During the session, some good work was turned out, and when the March Evening Institute held its annual exhibition the model engineers were well to the fore. The photograph gives some idea of unfinished models including a Fowler road locomotive and a semi-portable which were loaned by Mr. Darby of Sutton, Cambs. Mr. Darby has full-size road engines, too, which he is willing to steam up one Saturday afternoon for local model engineers.

With the end of the winter session the Model Engineering Class decided to see if the Model Engineering Society could be revived. A very serious meeting was held and the March and District Society of Model Engineers was reborn. It was decided to remain under the wing of the Evening Institute and continue to meet in the fully-equipped metalwork room. Needless to say, all members are grateful to the local Education Authority and the Hereward School.

The summer session started on May 3rd, and will continue until July 5th. Anyone interested is welcome to drop in at the metalwork room on Tuesday evenings between 7.0 and 9.0 p.m. The society secretary is Mr. L. J. OATEY, 30, St. John's Road, March, Cambs.—B. HALL, A.M.I.E.D., A.M.S.E.

Edinburgh Society of Model Engineers

Our winter session was completed by a demonstration of brazing and welding by Mr. S. Blyth, one of our club members, followed by a visit on May 10th to Haymarket locomotive sheds.

Unfortunately negotiations for the new track site have been unduly prolonged by various Town Council Committees, but we have been promised a definite decision in the near future. In the meantime the track at Clark Road will be put into operation and locomotives will be run as formerly.

The workshop and club rooms at 1a, Ramsay Lane are open on Tuesday evening from 7.30 p.m. and Saturday afternoon from 3.0 p.m.; all interested are welcome.

Hon. Secretary: J. H. FARR, Wardie Garage, Ferry Road West, Edinburgh, 5. Tel. No. 84176.

The West Riding Small Locomotive Society

For our rally, June 25th-26th, tickets are still available and the response to our previous notice has been very encouraging.

It is our intention that this rally shall become an annual event, and response to this year's rally will give us valuable information for future years.

We welcome "lone hands," and especially non-locomotive owners who are interested, so "roll up" all.

Hon. Secretary: F. W. SPENCER, 179, Raikes Lane, Birstall, near Leeds.

Canterbury Society of M. & E.Es. (New Zealand)

The 22nd annual meeting of the above society was held in the club rooms in Christchurch on May 3rd, 1955. Officers were elected, and the finances of the society found satisfactory. The 400 ft. multi-gauge track is nearing completion.

Hon. Secretary: J. CAVERHILL, 118, Harewood Road, Christchurch, N.Z.

THE MODEL ENGINEER DIARY

June 18th.—Ickenham & District Society of Model Engineers.—Official opening of new permanent headquarters and exhibition of models. Ground behind the "Coach & Horses," by Ickenham Pump, Middlesex.

June 19th.—Coventry Model Engineering Society.—Regatta at Nauls Mill Park, Coventry. Starting at 11.30 a.m.

June 25th.—Bristol Society of Model and Experimental Engineers.—Public days at the track, Canford Park.

June 25th and 26th.—The West Riding Small Locomotive Society.—Rally of Model Locomotives, Gauges 2½ in. to 7¼ in., at Blackgates House, Bradford House, Tingley, Wakefield. Open from 10 a.m. to 10 p.m. both days.

June 26th.—Victoria Model Steamboat Club.—Regatta at Victoria Park, Hackney, London, E.9. Starting at 11.0 a.m.

July 9th.—Vickers-Armstrongs Limited (Weybridge) Model Club. Annual exhibition at Vickers-Armstrongs Limited, Sports Ground Kings Head Lane, Byfleet, Surrey.

July 24th.—Brighton and Hove Society of Model Engineers.—Regatta on Hove Lagoon. Starting time 11.0 a.m.

August 9th, 10th, 11th, 12th and 13th.—Weymouth & District M.E.S.—Exhibition of models, at the Melcombe Regis Boys School, Weymouth. Open from 11.0 a.m. to 9.0 p.m. daily.

August 10th, 11th, 12th and 13th.—Exmouth and District S.M.E.E.—Exhibition at the Y.M.C.A. Hall, Victoria Road, Exmouth. Open at 7.30 p.m. on August 10th. Remaining days open from 10 a.m. to 9 p.m.

August 10th, 11th, 12th and 13th.—Isle of Wight Model Engineering Society.—Annual exhibition at the Secondary Grammar School, Nodehill, Newport, I.W. Open on Wednesday, Thursday and Friday from 2.30 p.m. to 9.0 p.m., Saturday 10.30 a.m. to 9.0 p.m.

August 17th, 18th, 19th, 20th, 22nd, 23rd, 24th, 25th, 26th and 27th.—The Model Engineer Exhibition, in the New Horticultural Hall, Greycoat Street, Westminster, S.W.1. Open from 11 a.m. to 9.0 p.m.

September 17th.—Guildford Model Engineering Society.—Annual exhibition at St. Saviour's Hall from 11.0 a.m. to 9 p.m.

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Buck & Ryan for Lathes and Accessories, drilling machines, grinders, electric tools, surface plates, etc.—310-312, Euston Road, London, N.W.1. Phone: Euston 4661.

For Your Myford M.L.7. 5-station turret attachment with novel features. Price £14 10s. 0d. or deposit £2 10s. 0d. and twelve monthly payments of £1. S.A.E. for descriptive leaflet.—WANSTEAD SUPPLY CO., 48. High Street, London, E.11.

Rebuilt Lathes. The Acorn Machine Tool Co. (1936) Ltd., offer rebuild to limits "Acorntools" and "Atlas" 10" swing s.s. available. Write—610-614, Chiswick High Road, W.4. (Phone: CHI 3416.)

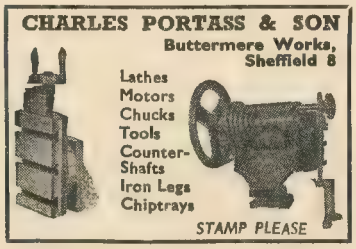
Government Surplus: Wimet tipped lathe tools ¼", 5/16", ⅜" square, sets 12 tools, price £2 10s. 0d. cash or by C.O.D. New M.L.7, Super 7, and Malcar 4½" lathes. Your old lathe taken in part exchange. Used lathe list 1s. H.P. terms to suit your pocket, from —CORBETT'S (LATHES), Stanton Hill, Sutton-in-Ashfield.

The Acorn Machine Tool Co. (1936) Ltd. are in a position to undertake the complete rebuilding of Atlas, Acorntools, Sphere and Halifax lathes, or if preferred, we can supply any spare parts that may be required for these mcahines. Full range of accessories and equipment for all these machines also available. Generous allowance given on old machines against the supply of new "Acorn" lathes. Second-hand machines of Atlas and Acorntools manufacture, rebuilt by us available from £75 each. Write to—610-614, Chiswick High Road, W.4. Tel.: Chiswick 3416-7-8-9.

Workshop Comprising: Small Exe centre lathe, ⅜" spindle cap., 16 speeds, many attachments, motorised c.i. cabinet stand; little lathe 5/16" spindle cap., chucks, etc., 15' line shaft, bearings, pulleys, single phase repulsion motor; nibbler, 12" throat. 3/16" plate cap., 150 r.p.m.; Q. & S. No. 4 flypress, Besco 12" treadle guillotine, 6' steel bench, 6" hand shaper, swaging machine and bending rolls. £150 o.n.o.—RIEMSDIJK, 40, Bancroft Avenue, London, N.2.

Wanted. Little John Lathe, second-hand but in good condition. Please give age and accessories.—Box No. 7665, MODEL ENGINEER Offices.

Hardening and Tempering Engineers' Tools, by George Gentry. The principles and practice of hardening and tempering processes including notes on forging, case hardening and the treatment of special steels. 3s. 6d. from your bookseller, or 3s. 9d. post free from—PERCIVAL MARSHALL & Co. LTD., 19-20, Noel Street, London, W.1.



Wanted. ½" Capacity drilling machine, belt drive or motorised 230 volt, bench or pedestal type.—Box No. 7748, MODEL ENGINEER Offices.

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Wanted. Engraving Machine, M.L.7 attachments MA68/1, 1467, 1468, 3-jaw chuck.—MAY, Ferndale, Gipsy Lane, S.W.15.

Winfield Centre Lathe, two chucks, countershaft, motor, vertical-slide, accessories. ½" vertical bench drill.—SMOLLETT, 61, Kilmaurs Street, Glasgow, S.W.1.

The Warner & Swasey Co. Capstan Lathe ½" capacity complete on stand and tray, 10 collets countershaft and pulleys, belting. Coventry die-head and dies. Archer tapping chucks, die attachment, box tool, six toolposts, etc., £65. Also Crompton Parkinson 3 h.p., 1,430 r.p.m. 5 amp. motor with armhead starter, £12 10s. 0d., cartage extra.—24, Nightingale Lane, Wanstead, E.11.

Wanted. Swivel Vertical-slide for 3½" lathe, also double ended grinder 6" minimum. Prepared to buy machine that can be rewound or repaired. State defects. —Phones: day, Ealing 7051; evening Uxbridge 3304.

Wanted. 2½" or 3½" Lathe. Details and price please.—10, Pembury Road, South Norwood S.E.25.

Sale. Portass, 3" × 18" B.G.S.C. lathe 3-speed Albion gearbox on wood bench. Good condition, three chucks, two drill chucks, equipment, tools, etc. 110 volt., ½½h.p. motor, 110-440 volt, 3.5 amp transformer, £35, o.n.o. Buyer collects.—H. ROBINSON, 8, Lowfield Lane, Balderton, Newark, Notts.

M.L.7, 1/3 h.p. Motor, reversing switch, 4-tool turret, tailstock lever attachment, 3-jaw and drill chuck. Few months since new. Originally over £70—£50. Romford.—Box No. 7753, MODEL ENGINEER Offices.

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MILLIGAN'S
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Crompton Parkinson ¼ h.p. Motors, 230/240 volt, 1-phase, 50 cycles, 1,435 r.p.m. Continuous rating, split phase, body 5½" dia., shaft ⅝" dia., no feet but easily clamped. Only limited quantity available. Brand new, 50s. each, 5s. carriage English and Scottish mainland.—S. G. YOUNG, 154/6, Blackfriars Road, London, S.E.1. WATerloo 3131 (5 lines).

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The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 *inclusive or a woman aged* 18-59 *inclusive unless he or she or the employment, is excepted from the provisions of the Notification of Vacancies Order,* 1952.

Sales Engineer Having Purchased Small Factory, Chertsey, Surrey, requires competent all-round practical machinist tool-maker, together with high-grade fitter for machine tools and engines on working partnership basis. Salary and output bonus and share holding gratis after satisfactory trial, apply with full details experience, age, etc., will to work and general "know how" essential.—Box No. 7749, MODEL ENGINEER Offices.

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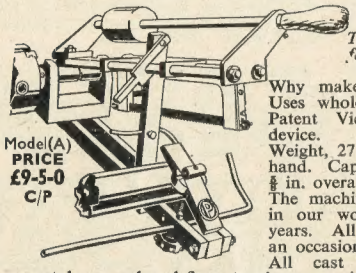

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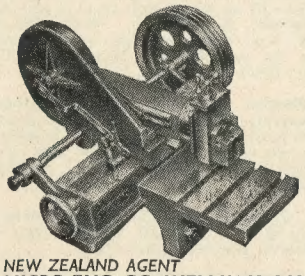

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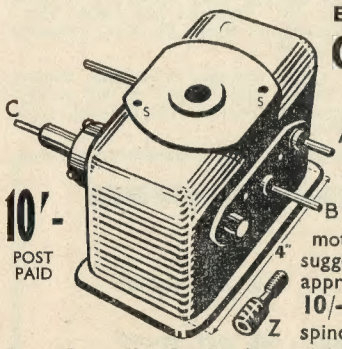

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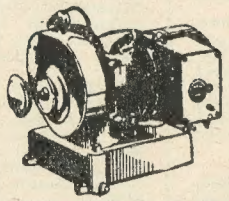

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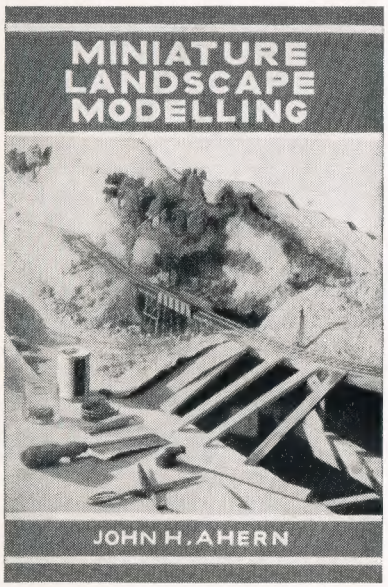

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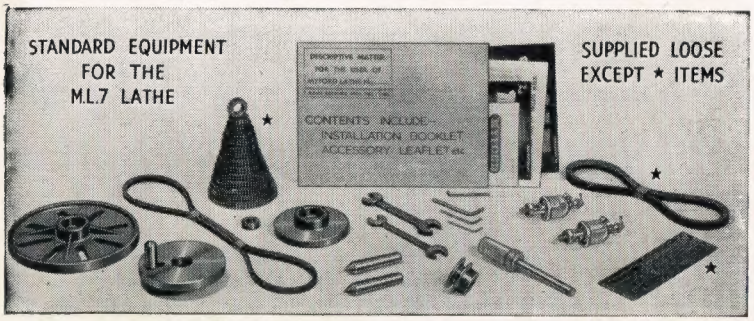

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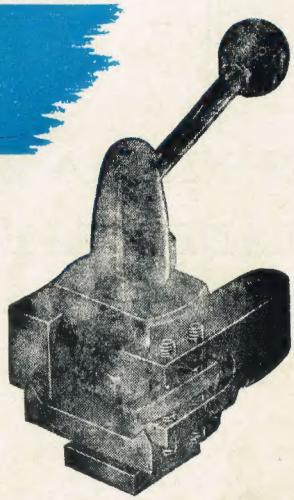

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